APPENDIX

A

Growth Forecast

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GROWTH FORECAST

A. Chronology of 2004 RTP Growth Forecast Development

April 2001: Regional Council adopted a plan forecast, through the year 2025, as a part of the 2001 RTP.

October 2001 – September 2002: The trend projection was developed based on the recent demographic and economic trends up to 2000, reflecting the change of the base year (from 1997 to 2000) and the target year (from 2025 to 2030).

September 2002 – December 2002: Feedback from subregions was received from September 2002 to December 2002 for the local input projection. More than 90% of local jurisdiction in the region provided local input.

December 2002- June 2003: Five alternative growth projections were prepared for a further review. They include trend projection, local input projection, technically balanced growth projection (TBGP), and growth visioning alternatives (PILUT 1, PILUT 2).

July 2003 – October 2003: Adjustments to the trend projection were made for use as No Project RTP/EIR alternative forecast. The adjustments are based on the recent demographic and employment trends between 2000-2003. The growth visioning alternatives (PILUT 1 and PILUT 2) were developed into a preferred plan alternative. A plan forecast is a result of combination of a preferred growth alternative and privately-funded projects.

B. No Project Forecast Methodology

B-1. Demographic Forecast Methodology

B-1-1. Regional and County Demographic Trend Projection

Regional Population Projection

1. Base Year Estimate

SCAG initially estimates the base year total population by age, sex, and ethnicity using the 2000 Census. Then the census total population by age, sex, and ethnicity is normalized to the July 2000 DOF estimate. The base year total population by age, sex, and ethnicity is computed as follows:

$$POP_{t_{2000}}^{county} = A_p * CPOP_{t_{2000}}^{county}$$

where

$POP_{t_{2000}}^{county}$ = adjusted total population by age, sex, and ethnicity in 2000
A_p = adjustment factor, which is derived by dividing July 2000 DOF total population estimate by 2000 census total population estimate
$CPOP_{t_{2000}}^{county}$ = total population by age, sex, and ethnicity from 2000 census

SCAG estimates the base year group quartered population in the following way.
The group quartered population by sex, age, and ethnicity is calculated from 2000 census data. Since only three age groups are available and Black/Asian groups include Hispanic population in the 2000 census, these raw data was converted into the standardized category of 18 age groups and four exclusionary ethnic groups using the 1990 and 2000 census data. Then the census group quartered population is normalized to the July 2000 DOF estimate.

$$GQ_{t_{2000}}^{county} = A_p * B_g * CGQ_{t_{2000}}^{county}$$

where

$GQ_{t_{2000}}^{county}$ = adjusted total group quarter population in 2000.
A_p = adjustment factor, which is derived by dividing July 2000 DOF total population estimate by 2000 census total population estimate.
B_g = adjustment factor based on the proportion of total group quartered population by age, sex, and ethnicity from 1990 census
$CGQ_{t_{2000}}^{county}$ = total group quartered population by age, sex, and ethnicity from 2000 census

The civilian resident population to be used for running the cohort component model is derived by subtracting adjusted group quartered population from adjusted total population.

$$RES_{t_{2000}}^{county} = POP_{t_{2000}}^{county} - GQ_{t_{2000}}^{county}$$

where

$RES_{t_{2000}}^{county}$ = civilian resident population by age, sex, and ethnicity in 2000
$POP_{t_{2000}}^{county}$ = adjusted total population by age, sex, and ethnicity in 2000
$GQ_{t_{2000}}^{county}$ = adjusted group quartered population by age, sex, and ethnicity in 2000

The aggregation of county level total population, group quartered population and civilian resident population results in the regional total population, group quartered population and civilian resident population, respectively.

2. Regional Population Trend Projection

2-1. Cohort-Component Model

SCAG projects regional population using the cohort-component model. The model computes the population at a future point in time by adding to the existing population the number of group quartered population, births and persons moving into the region during a projection period, and by subtracting the number of deaths and the number of persons moving out of the area. This process is formalized in the demographic balancing equation

$$POP_{t_{2040}}^{region} = POP_{t_{2000}}^{region} + GQ_{t_{2000-2040}}^{region} + B_{t_{2000-2040}}^{region} - D_{t_{2000-2040}}^{region} + NETMIG_{t_{2000-2040}}^{region}$$

where

$POP_{t_{2040}}^{region}$ = total population in 2040
$POP_{t_{2000}}^{region}$ = adjusted total population in 2000
$GQ_{t_{2000-2040}}^{region}$ = group quartered population between 2000 and 2040
$B_{t_{2000-2040}}^{region}$ = births between 2000 and 2040
$D_{t_{2000-2040}}^{region}$ = deaths between 2000 and 2040
$NETMIG_{t_{2000-2040}}^{region}$ = net migrants between 2000 and 2040

The following is a description of how components of population change are projected using the projection period of 2000-2005 as an example.

- Group quarter population

$$GQ_{t_{2005}}^{region} = RES_{t_{2005}}^{region} * CGQR_{t_{2000}}^{region}$$

where

$GQ_{t_{2005}}^{region}$ = group quarter population in 2005.
$RES_{t_{2005}}^{region}$ = regional civilian resident population in 2005
$CGQR_{t_{2000}}^{region}$ = the ratio of group quartered population to total population from 2000 census

- Births

$$B_{t_{2000-2005}}^{region} = BASEFEM_{t_{2000}}^{region} * FERTR_{t_{2000-2005}}^{region}$$

where

$B_{t_{2000-2005}}^{region}$ = births between 2000 and 2005
$BASEFEM_{t_{2000}}^{region}$ = base female population would be one of civilian resident female population, female inmigrants, female immigrants of child bearing ages (10-49)
$FERTR_{t_{2000-2005}}^{region}$ = fertility rate between 2000 and 2005

- Deaths (Survived Population)

$$D_{t_{2000-2005}}^{region} = BASEPOP_{t_{2000}}^{region} * MORTALR_{t_{2000-2005}}^{region}$$
$$SURVR_{t_{2000-2005}}^{region} = 1 - MORTALR_{t_{2000-2005}}^{region}$$
$$S_{t_{2000-2005}}^{region} = BASEPOP_{t_{2000}}^{region} * SURVR_{t_{2000-2005}}^{region}$$

where

$D_{t_{2000-2005}}^{region}$ = deaths between 2000 and 2005
$MORTALR_{t_{2000-2005}}^{region}$ = life table mortality rate (q_x) between 2000 and 2005
$SURVR_{t_{2000-2005}}^{region}$ = life table survival rate ($1-q_x$) between 2000 and 2005
$S_{t_{2000-2005}}^{region}$ = survived population between 2000 and 2005

- Net Migrants

$$NETMIG_{t_{2000-2005}}^{region} = INMIG_{t_{2000-2005}}^{region} - OUTMIG_{t_{2000-2005}}^{region} + IMMIG_{t_{2000-2005}}^{region}$$
$$INMIG_{t_{2000-2005}}^{region} = BASEPOP_{t_{2000}}^{us} * INMIGR_{t_{2000-2005}}^{region}$$
$$OUTMIG_{t_{2000-2005}}^{region} = BASEPOP_{t_{2000}}^{region} * OUTMIGR_{t_{2000-2005}}^{region}$$

$$IMMIG^{region}_{t_{2000-2005}} = IMMIG^{us}_{t_{2000-2005}} * RSHARE$$

where

$NETMIG^{region}_{t_{2000-2005}}$ = net migrants between 2000 and 2005
$INMIG^{region}_{t_{2000-2005}}$ = domestic inmigrants to the region between 2000 and 2005
$OUTMIG^{region}_{t_{2000-2005}}$ = domestic outmigrants from the region between 2000 and 2005
$IMMIG^{region}_{t_{2000-2005}}$ = international net immigrants (including legal and undocumented) to the region between 2000 and 2005
$INMIGR^{region}_{t_{2000-2005}}$ = inmigration rates measured in the ratio of inmigrants between 2000 and 2005 to total US population in 2000
$OUTMIGR^{region}_{t_{2000-2005}}$ = outmigration rates measured in the ratio of outmigrants between 2000 and 2005 to total regional population in 2000
$IMMIG^{us}_{t_{2000-2005}}$ = net international immigrants into the US between 2000 and 2005
$RSHARE$ = regional share of U.S. international immigrants (including legal and undocumented)

The fertility, mortality and migration rates are projected in 5 year intervals for 18 age groups, for four mutually exclusive ethnic groups: Non-Hispanic White, non-Hispanic Black, non-Hispanic Asian and Hispanic. These demographic rates are also projected by population classes: residents, domestic migrants and international migrants.

2-2. Balance of Labor Demand and Labor Supply

SCAG links population dynamics to economic trends, and is based on the assumption that patterns of migration into and out of the region are influenced by the availability of jobs.

The future labor force supply is computed from the population projection model by multiplying civilian resident population by projected labor force participation rates. It is formulated in a following way.

$$LFS^{region}_{t_{2040}} = RES^{region}_{t_{2040}} * LFPR^{region}_{t_{2040}}$$

where

$LFS^{region}_{t_{2040}}$ = regional labor force supply in 2040
$RES^{region}_{t_{2040}}$ = regional civilian resident population in 2040
$LFPR^{region}_{t_{2040}}$ = regional labor force participation rate in 2040

This labor force supply is compared to the labor force demand based on the number of jobs projected by the shift/share economic model. The labor force demand is derived using two step processes. The first step is to convert jobs into workers using the double job rate. The double job rate is measured by the proportion of workers holding two jobs or more to total workers.

$$WRKR_{t_{2040}}^{region} = JOB_{t_{2040}}^{region} / (1 + DOUBLER_{t_{2040}}^{region})$$

where

$WRKR_{t_{2040}}^{region}$ = regional workers in 2040
$JOB_{t_{2040}}^{region}$ = regional jobs in 2040
$DOUBLER_{t_{2040}}^{region}$ = regional double job rate in 2040

The second step is to convert workers into labor force demand using the ideal unemployment rate.

$$LFD_{t_{2040}}^{region} = WRKR_{t_{2040}}^{region} / (1 - UNEMPR_{t_{2040}}^{region})$$

where

$LFD_{t_{2040}}^{region}$ = regional labor force demand in 2040
$UNEMPR_{t_{2040}}^{region}$ = ideal unemployment rate in 2040

If any imbalance occurs between labor force demand and labor force supply, it is corrected by adjusting the migration assumptions of the demographic projection model. Adjusted migration assumptions are followed by total population changes.

Regional Household Projection

1. Base Year Estimate

SCAG estimates the base year households in the following way. The households by age and ethnicity is calculated from 2000 census data. Since Black/Asian groups include Hispanic population in the 2000 census, households for these two groups is converted into the standardized category of two exclusionary ethnic groups using the 1990 and 2000 census data. Then the adjusted census households by age and ethnicity are normalized to the July 2000 DOF estimate.

$$HHLD_{t_{2000}}^{county} = A_h * B_h * CHHLD_{t_{2000}}^{county}$$

where

$HHLD_{t_{2000}}^{county}$ = adjusted households by age and ethnicity in 2000.
A_h = adjustment factor, which is derived by dividing July 2000 DOF household estimate by 2000 census household estimate.
B_h =adjustment factor based on the proportion of households by age and ethnicity from 1990 census
$CHHLD_{t_{2000}}^{county}$ = households by age and ethnicity from 2000 census

The aggregation of county level total households results in the regional total households.

2. Regional Household Trend Projection

SCAG projects regional households by using projected headship rate. The projected households at a future point in time are computed by multiplying the projected civilian resident population by projected headship rates. It is formulated in a following way.

$$HHLD_{t_{2040}}^{region} = RES_{t_{2040}}^{region} * HEADR_{t_{2040}}^{region}$$

where

$HHLD_{t_{2040}}^{region}$ = regional households by age and ethnicity in 2040
$RES_{t_{2040}}^{region}$ = regional civilian resident population by age and ethnicity in 2040
$HEADR_{t_{2040}}^{region}$ = regional headship rates by age and ethnicity in 2040

Headship rate is the proportion of a population cohort that forms the household. It is specified by age and ethnicity. Headship rate is projected in 5 year intervals for seven age groups (for instance, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75+), for four mutually exclusive ethnic groups.

County Population and Household Projection

As used in the regional population and household projection, SCAG uses the cohort-component model and the headship rate to project the county population and households.

The sum of county projections is compared to the regional independent projections. If results are significantly divergent, input data at the county level is adjusted to bring the sum of counties projection and the regional independent projections more closely in line.

Complete agreement between two projections is not mandatory. After analysis, the sum of counties constitutes the regional No Project projections.

B-1-2. Sub-County Demographic Trend Projection

SCAG projects sub-county demographic trend projections using the housing unit method, which is one of the most widely used methods for estimating and projecting local area households and population for planning purposes.

The housing unit method consists of the following three steps. First, occupied housing units (households) are estimated by extrapolating the past trend of occupied housing units. The methodology for developing the occupied housing projection is a constrained extrapolation using stochastic simulation. The input data series can include up to 21 observations by combining information from the California Department of Finance E-5 series with enumeration-based values from the 1980, 1990, and 2000 censuses. The model parameters are estimated using the 21 observation series for each city. The trend extrapolations will not consider anything beyond historical trends in the data. Institutional constraints, land constraints, and build-out scenarios from general plans will not be considered in the trend projection.

Second, household (residential) population is estimated by multiplying occupied housing units (households) by the projected average household size. The average household size projection is problematic given the tension between expectations for a strong demographic component in the methodology and the lack of suitable data to support such a methodology. The so called 'state-of-the-art' for average household size projections tends to be very rudimentary at the city level. A constrained trend extrapolation of the E-5 average household size values is used with bounds determined by expert opinion, currently [1.2, 5.5].

Third, projected group quartered population is added to projected household population.
The group quartered population is projected based on 2000 ratio of group quartered population to total population.

FINAL REPORT

POPULATION AND HOUSEHOLD PROJECTION METHODOLOGY FOR CITIES AND SUBREGIONS

JUNE 2003

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

This document provides an overview of several alternative methodologies that could be used to project households and population for the SCAG region. The current endeavor is to produce a set of *trend projections* that exclude the influence of local institutional constraints or development scenarios. This report describes methods suitable for the trend extrapolation and suggest other methods that may be appropriate for the *baseline forecast* and *plan forecast*. The report also explores methods that are not currently feasible given currently available data sources but may be feasible for future trend projections.

The overall framework for the projections is circumscribed by several key decisions made by SCAG staff. First, the methodologies are required to be consistent with the housing unit method. This is an certainly a reasonable choice since the housing unit method is essentially the state-of-the-art for small area estimates and projections. Second, all city and subregion projections are constrained to be non-negative. This constraint is motivated by political and administrative considerations. Third, vacancy rates will not be explicitly projected. This forces a major deviation from the logic of the housing unit method but the choice makes political sense. Instead the households (occupied housing units) will be projected. Finally, as noted above, the *trend extrapolations* will not consider anything beyond historical trends in the data. Institutional constraints, land constraints, and build-out scenarios from general plans will not be considered in the current round of forecasts.

Though the document is wide-ranging, the constraints above force a choice among a small set of alternatives at the current stage of the planning process. The projections can be broken down into two main modules: (1) occupied housing units, and (2) persons per household. The remainder of this summary provides an overview of the alternatives under each module, with references to the detailed sections in the main document, and my recommendations.

Occupied housing unit projections
The alternatives for the occupied housing projection are related to the data inputs rather than the methodology. The methodology is a constrained extrapolation using stochastic simulation (sections 3.2 and 3.4). The input data series, as described in section 3.1, can include up to 21 observations by combining information from annual time series, either the California Department of Finance E-5 series or the U.S. Census Bureau building permit series, with enumeration-based values from the 1980, 1990, and 2000 censuses. The E-5 series seems to be the better choice (see section 3.1). The second issues is whether model parameters should be estimated using the 21 observation series for each city or if the long-term trends reflective in the absolute change between 1980 and 2000 (two observations per city) would be more reflective of the future.

Thus, the two options are:

(1) use the 21 observation series for each city, or,

(2) use only two observations, the earliest and latest values, per city.

My recommendation is option 1, see section 3.1, but the decision should be put to the members of the FTTF.

Persons per household forecast
The PPH projection is more problematic given the tension between expectations for a strong demographic component in the methodology and the lack of suitable data to support such a methodology. The so called 'state-of-the-art' for PPH projections tends to be very rudimentary at the city level. Section 4.3 describes two demographically-driven models but both fail on different accounts. One due to data limitations and the experimental/ 'un-tested' nature of the methodology. The other due to significant internal validity issues with the methodology. The feasible alternatives at the current time are described in sections 4.1 and 4.2.

Again, there are two options:

(1) use the evolution of the occupied housing type mixture in conjunction with city level PPH by type values to project total PPH, or,

(2) use a constrained trend extrapolation of the E-5 PPH values with bounds determined by expert opinion, currently [1.2, 5.5].

My recommendation is neutral in this case. The decision should be made after general discussion by the FTTF.

1. INTRODUCTION

This document provides a description of alternative projection methodologies that will be used to produce a final set of trend population and household forecasts at the small area level for the SCAG region. The base year for the projection is 2000 and the target year is 2030. To start, we should note that we assign distinct meanings to the terms *projection* and *forecast*, following Isserman (1991). The term *projection* refers to conditional if-then outcomes. That is, a projected value is simply the logical extension of assumptions used in a model. The sections below discuss several alternative projection models for each of the components of the housing unit projection method. The term *forecast* refers to the one projection model, or equivalently one set of assumptions, that the forecaster expects will be the most representative over the forecast period; in this case 2000 to 2030. Whereas the projections are logical extensions of a set of assumptions, forecasts reflect the expert opinion of the forecasting team. The trend forecast of population and housing will be derived from the subset of projection models that seem most appropriate given the weight of both empirical and contextual evaluation criteria.

The nature of constraints imposed on the projections process are worth noting at the outset. There are three distinct domains that impose limits on the projections: (1) political/administrative, (2) data availability/quality, and (3) methodological. The first domain is concerned with the expedience of administrative process and the anticipated political salience of model assumptions and results among constituency groups. The second and third domains are traditional concerns in any model building exercise. In the small area context, the data availability and data quality concerns are severe. Each of the three domains impose fundamental limits on the process with commensurate impacts on the resulting projected values.

Another overarching consideration is the decision by SCAG staff to partition projections into a *trend projection*, a *baseline forecast*, and a *plan forecast*. Some of the elements below would only be considered in the *baseline forecast* and *plan forecast*. They are included here to provide a complete statement of the proposed methodology.

Lastly, the objective in the current round of trend projections is twofold. On the one hand, the current exercise needs to produce a trend projection to be reviewed by local jurisdictions and subregions. On the other hand, the methodological developments may not be feasible in the current round due to data limitations, political constraints, or simply time limits or budgetary constraints. Yet, any developments which are not operationalized during this round will provide a useful basis for the next round of trend projections in 2005 and may inform future data collection needs.

2. HOUSING UNIT METHOD: OVERVIEW

The overall methodological framework for the small area projections is provided by the housing unit method. The housing unit approach is an often used, and widely accepted, small area estimation and projection methodology. For small area intercensal estimates, the population (P_t) is estimated as the group quarters (GQ_t) population plus the product of occupied housing units (H_t) and average persons per household (PPH_t). In most applications the group quarters contribution is negligible and the accuracy of the estimate depends on the ability to estimate, either directly or by proxy, the number of new and demolished housing units, the vacancy rate, and the average number of persons per unit.

In a projections context, each of the three components of the relationship are projected into the future. Thus, the projected population in year $t+n$ is expressed as

$$\hat{P}_{t+n}=(\hat{H}_{t+n}*P\hat{P}H_{t+n})+G\hat{Q}_{t+n} \quad (1)$$

where the hats indicate projected values. In the standard approach the number of occupied housing units is derived from three other forecasts including new housing units, demolished housing units, and the vacancy rate. The first two sum to the total number of housing units, after adjusting for the base year housing stock.

The methodological choice of the housing unit method was imposed by the SCAG staff. It is a reasonable choice since it is essentially the 'state-of-the-art' method for making either estimates or projections at the small area level. It is used by most state demography agencies and by the U.S. census bureau. It is also noteworthy that the method has persisted for almost 50 years without any major modifications to the approach. That stagnancy speaks to the paucity of data at the small area level, thus necessitating a simple method.

The methods proposed for the SCAG sub-county demographic projections attempt to improve on the housing unit method while remaining within its overall architecture stated in equation **(1)**. The traditional method is uni-regional, assumes spatial independence, and is not stochastic. Over the relatively long 30 year projection period, some of the most important considerations will be related to the impact of long-run demographic trends, the spatial evolution of the population composition, and the extent to which either administrative or resource constraints impede the creation of new housing units. The methods described below introduce spatial dependence, stochastic simulation, and a multiregional demographic sub-model. These improvements push the limits of the data but are also careful to incorporate all possible information into the projections.

The sections below discuss projection methods, data, and assumptions for each of the components in **(1)**. The last section of the methodology discusses the key assumptions that will be important to consider in the projections review stage.

3. OCCUPIED HOUSING UNITS BY TYPE

By definition, projection year total housing units will equal the number of current housing units plus newly built units over the projection period and less demolitions over the projection period. As noted previously, occupied housing units is derived from total housing units by multiplying the latter by a vacancy rate. Based on the political contentiousness surrounding projection year vacancy rates, or the proportion of seasonal housing, the SCAG staff decided to directly model occupied housing units. The lack of any demolition data provides an additional justification for proceeding directly with occupied housing units. The methods below apply equally to any historical housing series and could be adapted at a later date to project total housing units.

The subsections below propose projection methods that range from simple to complex; the complexity attempts to capture more realistic sets of conditions that we expect to prevail over the forecast period. The first subsection (3.1) describes the base data sources and modificatoins to that data, (3.2) describes standard extrapolation methods that are applied to population or employment projections, the second section (3.3) describes several approaches that can be used to derive city-level growth ceilings based on either prior growth, land use change, or both, and the third section (3.4) proposes a stochastic simulation method that accounts for spatial dependence in the housing unit projections. Section (3.5) describes some additional calculations needed for the sub-types of total occupied housing units.

3.1 Data

The primary data inputs used to project the number of occupied housing units are: (1) historical census enumeration data for occupied housing units by type at the city level, (2) historical building permit series at the city level, (3) the E-5 series of intercensal housing by type estimates from the California Department of Finance, Demographic Research Unit, and (4) high spatial resolution land use classification maps for the years 1990 and 1993. The enumeration data is from the 1980, 1990, and 2000 censuses. The building permit series are collected by the U.S. Census Bureau and provide information on the number of single-family and multi-family permits issued for the years 1980 to 2000. The E-5 series provides annual estimates of total housing and housing by type for 1980 to 2000. The land use maps provide the observed land use allocation by detailed land use classification based on the interpretation of aerial photographs. We are confident that the housing unit data and land use transition matrices (derived from the land use maps) provide a good indicator of future occupied housing unit trends.

The projections literature cites several common drawbacks associated with the permit data in both estimation and projection contexts. Some of the shortcomings include the inability to identify seasonal versus year-round housing units, that permits only indicate the intent to build, not evidence of a completed structure (this can be overcome by using 'certified' permit data), and that permits may indicate add-ons to existing structures rather than the creation of new units. Also, simple extrapolation models could predict more housing units than reasonably expected to occur given the extent of build out in a city, the availability of undeveloped land, and zoning constraints on existing land. In our case the building permit series from the census bureau only includes the number or permits and the number of units for new housing units. Moreover, by focusing only on occupied housing units the seasonality issue is immaterial.

The E-5 series provides an alternative information set capturing intercensal variations in housing growth with housing type detail. The estimates from the E-5 series are probably more accurate than the building permit information for at least two reasons. First, the state demographers are more aggressive in collecting information on city level changes than the U.S. Census Bureau. Therefore the base data is likely to be cleaner than the raw building permit figures. Second, state demographers are carefully impose important assumptions on the interpretation base data files. Importantly, building permit counts have a lagged transition into completed housing units. A similar lag assumption could be imposed on the census building permit series but that would merely duplicate efforts already executed by state demographers and reflected in the E-5 series.

The reason for using either the E-5 series or the building permit series is the same. The annual series provide an indication of the intercensal changes. In general, using a larger, more detailed information set should improve the resulting projections. The census enumeration data only provides one, two, or three data points for a given housing type and city depending on when the city was incorporated. By combining the relative rates of change from the annual series with the known enumeration values from the census, the combined series is up to 21 years in length (1980-2000). For cities incorporated after 1980 the series will be shorter. The combined E-5/census enumeration series passes through each of the observed decadal enumeration values and matches the relative rate of change from the E-5 data for the intercensal periods. Figure 1 displays four examples of the underlying data series that combine census data with the E-5 series. There are four data series derived from the data: one for total occupied units, one for single family occupied units, and one for multi-family occupied units.

One could make arguments the use of the longer, more detailed series just described. The 1990s in the SCAG region witnessed a significant shift from historical growth patterns. Southern California has traditionally been a fast growing region and future patterns are likely continue that long-term trend despite the economic recession and slow population and housing growth throughout much of the 1990s. This perspective would argue for only including the long-term growth reflected by change between 1980 and 2000. While this perspective is valid in noting the long-term growth prospects and aberrant pattern of the 1990s, the annual series may not only reflect the recession but also important fundamental constraints on the growth prospects for particular cities, independent of the recession. Some cities and regions erected significant institutional barriers to housing growth 1980s and 1990s. Other cities may have reached either natural limits or planned build-out limits during the 1990s. If either of these cases are true than the annual series would detect important trends that would not be reflected in the long-term growth rate. The annual series can also be justified on the ground that near-term annual variations exert less influence on the resulting projections than the 1980 data point. The latter point, given it's distance from the series mean, has more leverage on the parameter estimates of the extrapolation models. Therefore, the annual series essentially satisfies both concerns.

3.2 Extrapolation models

Extrapolation methods are used to predict the future values of a variable based on its observed historical time path. In this case, the occupied housing unit data series for each city is used to estimate the parameters of alternative functional forms.

Alternative functional forms are provided in Table 1. In each case the functional relationship can be transformed to a linear relationship (see Table 1). Given the linear transformed relationship, standard regression methods can be used to estimate the parameters of the non-linear functions. The predicted number of units for a given model is based on those parameter estimates. The adequacy of the functional relationship is assessed using standard input and output evaluation measures. The input measures are listed in the last column of Table 1, and each is simply a mathematical expression of the core assumption for each functional form. For example, the geometric growth equation implicitly assumes that the growth rate ($\frac{y_{t+1}-y_t}{y_t}$) is constant over the projection period. The input evaluation criteria test whether this assumption is true in the observed data series. The output evaluation criteria include standard measure of fit (Mean Absolute Percent Error) and bias (Mean Error). Once a final 'best fit' curve is selected, the parameter estimates are used to project the number of building permits from 2000 to 2030.

Figure 2 provides a graphical representation of each nonlinear functional form suitable for the extrapolation projections of the occupied housing unit data. The only curve not represented in the figure is a linear curve; we omit it since it is easy to visualize a straight line. Three of the four nonlinear functional forms require the input of a growth ceiling. In most cases, especially with a long projection period, it is unlikely that housing construction will continue unconstrained. This is certainly the case in cities that, for all practical purposes, have neither vacant land nor agricultural land. Without a calculating a growth ceiling, *c*, the only functional forms available to fit to the data are either a linear or geometric function.

The growth constraints are also extremely important in the current context since the city and subregion projected values have to add up to the county level totals derived using alternative methods. The constraints provide a means to operationalize the county control totals while still relying on historical city level trends.

3.3 Growth ceilings

The growth ceiling, c, in Figure 1 can be based on expert opinion or derived analytically from data that inform the nature of potential constraints. There are three potential constraints in the SCAG region: (1) water availability, $\boldsymbol{W}$, (2) institutional (e.g. zoning, development climate) constraints, $\boldsymbol{I}$, and (3) land availability, $\boldsymbol{L}$. The research team has already reviewed the available data from regional water districts and determined that there is insufficient information to develop plausible and empirically-informed water constraints. The institutional and land availability constraints can be quantified with current information, and subsequent studies currently in progress at SCAG will improve the ability to develop realistic growth ceilings. In addition, city-level constraints should also be informed by the historical growth trajectory, $\boldsymbol{G}$.

Given the foregoing discussion, the growth constraint should be proportional to a set of factors that inform the likely proportionate division of a known county total over a set of cities and unincorporated subregions. We could write the vector of constraints,

$$C \propto f(W,L,I,G) \qquad \textbf{(2)}$$

where the first three components would be excluded in a trend projection but would be included in a baseline forecast and a plan forecast. The growth trajectory is easy to operationalize given the county constraint and an observed growth increment over a representative historical period.

The proportionality, rather than equality, is used in (2) since the sum of the constraints have to equal the county control total; alternatively the city level constraint proportions, $p_i = \frac{c_i}{c_+}$, have to sum to one. In a stochastic simulation we could regard those proportions as multinomial probabilities; we will return to that point below.

We could also specify a particular functional form for (2) such as,

$$C \propto \tilde{W}^{\alpha_1} + \tilde{L}^{\alpha_2} + \tilde{I}^{\alpha_3} + \tilde{G}^{\alpha_4} \qquad \textbf{(3)}$$

where the tildes indicate that the variable have been normalized to lie between 0 and 1 and the superscript parameters, α, are a set of subjective weights indicating the relative strength of the factors expected to prevail over the forecast period. The weights could be set by an expert panel (such as the FTTF) or by participants in the local review process.

In considering the land use and institutional components of the constraints, there are three potential scenarios. In several cities the 1993 land use data indicates development environments that have already reached build-out. In those cases it is unrealistic to assume that growth in multifamily or single family units can occur without offsetting declines in other types of housing stock. In those cities new growth in population will primarily depend on changes in the occupancy rates (persons per household) discussed in section 3 below. A second scenario applies to cities on the urban fringe with relatively vast holdings of developable land (either vacant or agricultural). In those cases the constraints are calculated but are not binding over the forecast interval.

The third scenario is the most critical. In these cases, the cities or subregions have developable land but the constraint is binding over the projection period. The review process should look carefully at the validity of the constraint, both in terms of land use classifications and the institutional environment. For example, in Ventura and Oxnard there are large stocks of agricultural land but recent legislation has made it much more difficult to rezone the agricultural land for higher use.

The next two sections describe particular approaches that could be used to operationalize the land use portion of the constraint. The first is an accounting method based on land use classification maps. The second is based on the Landis's urban futures model.

Accounting method:
The first approach for identifying a growth ceiling is based on a simple accounting framework using the 1990 and 1993 land use classification maps. The basic idea is to use the observed changes during that period in conjunction with the observed building activity or growth in occupied units to derive an expected ceiling on single family and multifamily units. Note that this method would not be used for the *trend projection.*

Table 2 provides a simplified matrix of observed land use transitions during the 1990 to 1993 period. Panel A indicates the number of acres that have either stayed the same (main diagonal) or changed classifications. Panel B should be read across the rows. It indicates the proportion of a given land use type in 1990 that either remained the same or changed to a different type in 1993. Panel C indicates the net changes in acreage. The data in Table 2 represents aggregate changes for the entire SCAG region.

Similar matrices can be defined for each city and subregion within the SCAG region. Defining a city level land use change matrix as $\boldsymbol{L}$ with elements $\boldsymbol{l}_{ij}$, where the subscripts index the beginning and ending land use, we can define a building permit ceiling as

$$\left(\sum_{i=1}^{10}\sum_{j=1}^{2} l_{ij}\right) x \left(\frac{\sum_{i=1}^{10}\sum_{j=3}^{4} l_{ij}}{\sum_{i=1}^{10}\sum_{j=3}^{10} l_{ij}}\right) x \left(\frac{\sum_{t=1990}^{1993} b_{tl}}{\left(\sum_{i=1}^{10}\sum_{j=3}^{4} l_{ij}\right) - l_{33} - l_{44}}\right) \qquad \textbf{(4)}$$

The notation $\boldsymbol{b}_{tl}$ refers to the number of building permits issued, or growth in occupied units, in year t of type 1 (in this case single family dwellings). The three major terms enclosed in parentheses in **(4)** are interpreted as follows: the first term is the total undeveloped land (vacant plus agricultural), the second term is land in rural and medium density residential as a proportion of all developed land, and the last term is the observed units per acre for rural to medium density residential growth over the 1990 to 1993 period. The product of the first two terms yields the acres of undeveloped land that are expected to be developed as rural to medium density residential. The last term converts those acres into building permits or occupied units depending on the modeling context.

As shown in Figure 2, using 1993 as the benchmark, the value from **(4)** can be added to the existing cumulative permits issued up to 1993 to arrive a the growth ceiling, *c*.

Parametric ('Landis') model:
An alternative approach to modeling the land use constraint would be a parametric model of land use change. One alternative would be to build on the types of models developed by John Landis, a Professor of City Planning at UC Berkeley. For completeness, we provide a brief synopsis of his approach in this section. Our opinion at this time, is that the data sources are insufficient to take this approach and, moreover, the results may be comparable to the less demanding accounting method.

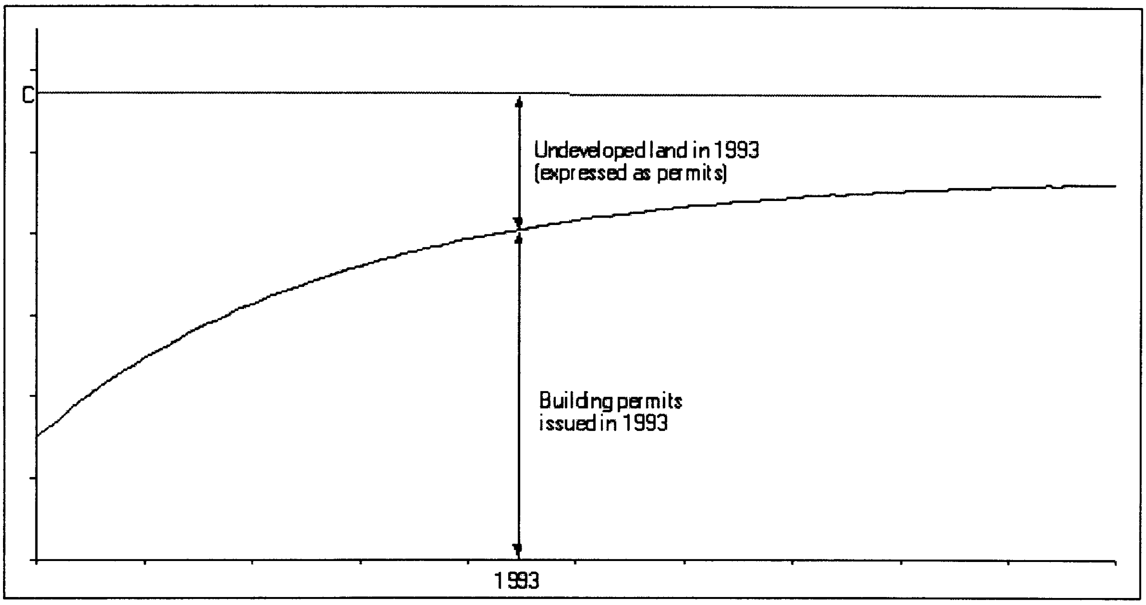


Figure 2: Calculation of growth ceiling, *c*

Landis' California Urban Futures Model (CUF-II) is an urban growth and land use change model comprised of three pieces: projections of growth, a multionomial logit land use change model, and a growth allocation module. In CUF-II an observation is one hectare observed in two different years with relevant descriptive data. A general logit model is fit to the observed land use transitions, and the parameters estimated can then be used to estimate the probability of transitioning from land use type *I* to land use type *J* for an arbitrary cell. Landis does not use CUF-II to estimate population. Rather, he produces an external population estimate and allocates the population based on the probability scores.

The are several potential problems with applying the Landis framework to the current context: (1) Population is estimated externally and any growth embedded in the land use change model results from the growth between the two years of observation; (2) Since transitions for a piece of land are estimated, standardized units would be desirable, either plots or cells (neither are available for this study); (3) Additional data is necessary to predict the probability of change; (4) Spillover rules would need to be developed.

Land use change models such as CUF-II might aid population projections with land constraints in three ways. First, the probabilities associated with each cell provide preferences for the land use for that cell. That information could be used to estimate the amount of land available for *residential* use. Second, land in adjacent regions may appear to be available for *residential* use when land constrains a region's growth. Third, the amount of land available for conversion from *non-residential* to *residential* use could be estimated. Likewise the amount of *residential* land converting to *non-residential* uses could be estimated and taken off-line.

3.4 Spatial dependence and stochastic simulation

The extant literature on projections using the housing unit method excludes methods to control for several important aspects of urban growth. It is very likely that the individual jurisdiction level time series will exhibit spatial dependence; that is, the time paths of series in proximate jurisdictions will be highly correlated. Another problem in the forecasting literature is that the final forecasts often only provide a single forecasted time path, and on occasion a high and low alternative. These outputs do not adequately represent the uncertainty in the final forecast.

Traditional population forecasts do not provide a measure of the uncertainty inherent in projections. Most important, a single population forecast typically underestimates the temporal variability of the observation record. Stochastic simulation amounts to generating alternative, equally likely, forecasts which are all consistent with the available information. Such alternative forecasts exhibit the correct spatiotemporal variability inferred from the data, and, taken as a set, provide a measure of uncertainty in population or housing growth.

The use of a growth constrain informed by city level growth trajectories, ***G***, provides a parsimonious method to incorporate information on spatial dependence. If growth is allocated based on prior growth, the natural spatial dependence in those growth patterns will implicitly be contained in the city level constraint.

Stochastic simulation can be incorporated by specifying probability distribution for the constraints, ***C***, and fitting constrained growth curves to each draw from the distribution. As noted above the problem of defining a set of small area projections equal to a region level constraint is identical to finding a set of multinomial probabilities with parameters defined by the proportions, $p_i = \frac{c_i}{c_+}$.

Using a Bayesian approach we would use the conjugate prior of the multinomial, the Dirichlet distribution, in conjunction with the observed growth increments. Additional uncertainty in the actual growth increments can be specified using a Beta distribution that allows the input to the Dirichlet to vary between an upper and lower bound. In the current projections the upper and lower bound are defined by the minimum and maximum of the set defined by 5-year $((H_{2000}-H_{1995})/5)$, 10-year $((H_{2000}-H_{1990})/10)$, and 15-year $((H_{2000}-H_{1985})/15)$ annual growth increments. The two parameters of the Beta distribution (w and v) are set by the analyst. In the current model the values are set at either (2,4) or (4,2) to sample more heavily in the direction of the 10-year annual growth increment since the SCAG staff seems to have some preference for that historical range. Another option would be to use (1,1) which specifies a uniform distribution with the range between the minimum and maximum discussed above.

A single iteration of the simulation involves three steps: (1) a draw from the Beta distribution for each city that defines a vector of annual growth increment realizations, (2) the vector is used to make a single draw from the Dirichlet distribution which outputs a set of proportions, and (3) the proportions define a set of city constraints consistent with the control total and those constraints are used to estimate the parameters of a particular growth curve (exponential, Weibull, or Gompertz). The simulation is repeated multiple times (10,000+) to define a distribution of growth curves for each city.

Finally, for each city simulation distribution and for each five-year increment of the forecast period (2005, 2010,..,2030) it is possible to recover a median value and an upper and lower probability bounds. Since the median is recovered for each five-year increment independently, the medians are drawn from different estimated growth curves. The median values are used to select a single growth curve for each city that has the smallest mean absolute deviation from the median.

Model runs to date indicate the exponential always provides the best fit to the historical data and provides the most plausible projection year values. Experimentation with the simulation also indicates that 10,000 simulated values produces stable projection estimates.

3.5 Additional calculations for units by type

The method described in section 2.3 works for total occupied housing units but a few additional steps are needed to calculate the occupied housing units by type (single-family detached, multi-family detached, mobile homes, and other). The basic method for single-family and multiple-family occupied units is identical to the simulation method discussed above. The mobile-home and other categories are derived using fixed rates from the 2000 census. The fixed rates are either in relation to total housing or in relation to the sum of single- and multi-unit occupied housing. At the end of that process, there are four series that each add up to the county control totals for each type of occupied housing unit.[1] The problem is that the sum over each type of occupied housing unit does not equal the total occupied housing value for each city. Iterative proportional fitting is used to force the 'by type' values to satisfy both the city occupied housing unit totals and the county occupied housing unit by type totals. The resulting data matches the marginal totals defined by the county control totals and total occupied units by city totals while retaining the odds ratios of the unadjusted 'by type' projections for each city.

4. HOUSEHOLD SIZE PROJECTIONS

Given projected occupied housing units from section 3, the next step is to estimate the resident population living in the occupied housing units. The resident population is derived by multiplying the number of occupied housing units by the persons per household (PPH). Spatial and temporal variation in PPH is related to several socio-economic factors. High PPH values, overcrowding, may be related to poverty, motivated by social-learning and safety concerns among recent immigrant (ethnic enclaves), or perhaps a pocket of concentrated housing demand characteristic around universities. Low PPH values could be linked to elderly populations and range of other social and economic pathologies. Ideally a PPH forecasting model would build on theories of household formation, immigration and assimilation, aging, and the economics of housing. Yet it is important to keep in mind that forecasting model deviate from explanatory models in their adherence to social science theories. Forecasting, by nature, relies on strong patterns that

[1] The county control totals for occupied housing units by type are projected separately. The forecasted county control totals for single family, multiple family, and mobile homes are produced using exponential smoothing time series models. The independent forecasts are forced to sum to the total occupied housing county control totals.

maximize predictive power[2]. Forecasting relies on time series data whereas explanatory models are typically specified using either rich cross-section data or small samples of longitudinal data. As such, model specifications available for forecasting are usually much more highly constrained by data than those available for explanatory modeling. Moreover, these constraints becoming increasingly stringent as spatial resolution is increased. This is certainly the case with PPH at the city and subregion level.

The sections below outlines four alternative methods that could be used to produce trend extrapolations for PPH. The most salient model from a theoretical and forecasting standpoint, the multiregional microsimulation in section 4.3 below, has data requirements that force undo reliance on model schedules and interpolation and that exceed the resources available for the current round of projections. The feasible alternatives for the current trend projections are relatively simple in form as dictated by data constraints.

4.1 Constant value, simple trend, or decomposition by type for persons per household

The standard approach is to either assume a constant PPH with the value taken from the last census or estimate a trend using past censuses. The constant assumption is unsatisfactory since constancy is unlikely to prevail. The trend projections are somewhat problematic since both the areal extent and the existence of cities in the SCAG region varies over the three census years (1980, 1990, and 2000). At most the historical data provides three values and in several instances only two values or a single value. Moreover, there are expectations that PPH will be trending up-then down- in many places which would impose a quadratic form on the extrapolations. Over a 30 year projection interval it is likely that the quadratic will dive sharply yielding unrealistic results.

Another possibility is to view changes in the total PPH value as the result of underlying changes in the composition of total occupied housing. The PPH values for different types of occupied housing show substantial variation. The median 1990 PPH values for single-family, multi-family, mobile, and other are, respectively, 3.1, 2.4, 1.9, and 2.7. Figure 3 shows the distribution of the four values over the 200 cities. Whereas, the single family PPH is higher and symmetric, the multi-family PPH is lower and highly skewed. Since the observed PPH values by housing type in particular regions are reflective of underlying differences in income distribution and other local features that may induce the degree of relative crowding, it is plausible to allow changes in the total PPH to emerge from the shifts in the composition of housing types and their respective PPH values. As the composition of housing shifts over time, the PPH will shift with it.

Figure 4 shows some sample results from using the 1990 PPH by type with an allowance for historical drift. The PPH by type values are then applied to the occupied housing unit by type forecasts to derive a total PPH value. The resulting plots show that even using a roughly fixed set of PPH rates, the resulting total PPH projected values are not fixed and can follow a non-linear path.

4.2 Constrained trend using expert information

[2] For example, the cohort-component model used for the county projections relies on the age-structure of fertility and mortality. The model is imminently simple in construction and avoids any detailed consideration of the economics of fertility. Even at the county level, the theoretically superior multiregional construction is jettisoned in favor of the simpler net migration formulation because of data availability and quality constraints.

One of the problems with a simple extrapolation model of PPH is that predicted values may violate plausible bounds on the range of PPH. The lower limit is clearly unity in theory but it is extremely unlikely that any city would consist entirely of one person households. For the upper limit values in excess of 6 would fall outside of any historical values observed in the region. One way to determine plausible bounds is to poll a panel of local experts. In this case, conversations with two experts on the Los Angeles area suggests bounds of 1.2 and 5.5. The validity of these bounds should be discussed by the Forecasting Technical Task Force.

This approach would involve three steps. First, constrained extrapolation curves would be fit to the historical data with values constrained to lie between 1.2 and 5.5. Next, the PPH value would be multiplied times the occupied housing for each city to calculate the resident population (recall equation 1). Finally, the projected resident population for each city would be rescaled to equal the county control totals for resident population. Note that the rescaled resident population values will imply a revised PPH for each city. If the revised PPH falls outside the bounds given above, iterative methods will be used to satisfy both the PPH constraints and the county control totals.

The constraints imposed on PPH could also be used in the decomposition approach described in section 4.1.

4.3 Incorporating demographic processes

Spatial demography model: multiregional demographic microsimulation

The estimation and projection of persons per household (PPH) is still an active area of research in the academic literature. A constant PPH is often unrealistic and research indicates that projection errors for PPH contribute the most to the total error in final forecasts based on the housing unit method. In the SCAG region, a constant PPH would seem to be a particularly bad assumption. The region continues to receive a substantial proportion of the new immigrants to the United States and those immigrant flows are highly spatially focused within the region. The effect of immigrant populations on PPH is particularly important to consider since immigrants and natives use the existing housing stock differently. In general, recent immigrant populations are characterized by much higher levels of overcrowding though the level of overcrowding varies by immigrant type. Moreover, there is evidence that foreign born populations have higher birth rates than the native-born population. As assimilation occurs the foreign-born population tends to follow a predictable path through the housing stock and fertility schedules converge towards the native-born population.

One way to explicitly account for such dynamics is to use a small area cohort-component model with detailed accounting for foreign-born / native-born categories. In particular, we could use a zip code level cohort model that tracks the age-disaggregate stocks of native-born and foreign-born, by year of entry, with each population subject to characteristic fertility schedules, migration schedules, and immigration schedules. Much of the variation in the foreign born is largely dependent on the fertility patterns prevailing in an immigrant's country of origin. Therefore the ideal model would also decompose the foreign born population by ethnicity - or at minimum Latino/non-Latino. The value of a multiregional cohort-component model is that it would allow the PPH values to emerge from the underlying demographic processes at a small spatial scale.

The problem with building an operational spatial demographic model is that it requires extremely detailed spatial data. The required city-level vital statistics (birth and death) and immigration flows can be estimated from the national microdata birth and death records and the INS zip code data. In both cases the data provides an incomplete picture for our purposes and spatial interpolation and model-schedules are required to develop a complete set of data accounts. The intraregional migration accounts are even more problematic. One source is the 1990 public use microdata (PUMS) in which the combinations of the sampling areas can be used to recover an incomplete geography of the SCAG region. This data could be combined with DMV records but that data is unavailable for the current round of projections. Overall the required data accounts place extreme demands on the available data sources and require the use of model schedules and smoothing techniques typically applied in developing country contexts.

Another option that partially captures the spatial dynamics is to use net migration rather than a complete matrix of interregional migration. The problem with net migration is that it is well establishment in the demography literature that the use of net migration in long-term projections will bias the resulting projections. Places with net out-migration will uniformly decline towards zero and those with net in-migration will trend towards a partitioning of the total population among the growing regions.

Demographic regression model: regression-extrapolation-imputation
An alternative approach would be to specify a predictive regression equation for PPH that includes relevant socio-economic variables as covariates. The regression equation would have to be specified using the 200 observations (cities and unincorporated subregions) for the SCAG region. The model parameters would be reflective of the overall region and may not be reflective of a particular city. Subregion dummy variables and interaction effects could be used to partially alleviate this problem.

Assuming that a regression equation specification does fit the cross-sectional data, the parameters would be used to predict future values of PPH for each city. There are several problems with this approach. First, the constant parameter assumption, commonly termed functional stationarity, would assume that the parameters do not drift over time (unlike state-space models where the parameters evolve over time). Second, the predictions of the PPH values assume the existence of forecasts for each of the independent variables. This means that each of the independent variables needs to be projected into the future. More importantly, it means that the errors in those projections will be pooled and perhaps amplified in the final predictions from the regression model.

Third, the if we are projecting individual independent variables such as population by ethnicity, we are only a small step removed from directly projecting total population. If that is the case, then why not just directly project total population. The information sets are essentially identical. In fact, projections of the independent variables either implicitly or explicitly assumes the existence of total population projections. The independent variables in the PPH regression should include things such as percent Latino, percent foreign born, proportion over age 65. The projections of those independent variables can either be done using levels constrained to the county control totals or direct projections of the percentages. The levels approach ensures consistency with the county control totals but the recovery of percentages necessitates projections of total population (the denominator of the percentages). The projection of percentages does not ensure consistency with county control totals and the total population projection is implicit in the percentages. Moreover, projection and time series methods for rates are less well defined than those for levels.

Overall, the functional stationarity approach is tempting but is rarely used because of the issues listed above. The statistical problems resulting in error propagation are a sufficient deterrent alone; the circularity of either implicitly or explicitly projecting the total population (as a denominator) provides an additional damning critique.

5. GROUP QUARTERS POPULATION

The group quarters population is composed of individuals living in university dormitories, military barracks, and prisons. One often-used assumption is that the group quarters population will grow at the same rate as the rest of the population; in other words, the group quarters population is a constant fraction of total population. Over the 30 year projection period, the use of that assumption would tend to overestimate the group quarters population.

One option here would be to use a survey sample to directly gather information about future facilities development plans among the major institutions in the region. Universities and prisons, for instance, have there own long-range plans which include future construction. It is also likely that the cost of such a survey would not be worth the improved information since the group quarters population is such a small share of the total population. A targeted survey to those communities where the group quarters population is relatively large would make the most sense.

6. KEY ASSUMPTIONS

The three main areas where assumptions should be subject to local review are in the three areas that traditionally account for the most error in forecast values. Those areas include the housing unit forecasts (section 3) and the occupancy rates (section 4).

Occupied housing unit projection assumptions:

- *Existence and nature of development constraints*: If the extrapolation procedures use an external constraint, the local review process should attempt to insure that the constraint is as reflective of reality as possible. The available data should only be viewed as a starting point. The local review process should focus on identifying sources of institutional constraints at the city level and quantifying those sources in terms of single family and multifamily units. The general plan build-out analysis currently underway at SCAG may help in the identification of more realistic constraint values.

- *Excluding zoning codes from the land use map*: We are currently excluding a range of land use codes (such as public infrastructure) and physical topographies (land slopes steeper than a given value). The exclusions remove acreage from the developable land category. The review process should evaluate whether the set of exclusions are sufficient, too strict, or too liberal.

- *Nature of new growth*: The methodology in equation (2) proceeds on the assumption that new development of single family and multifamily units will be added in proportions reflecting the existing development of the city. This assumption will likely understate the amount of land available to housing unit development since outlying areas will usually be developed at lower intensities (assuming a decreasing rent gradient) than the existing land uses. More conservative values to use in the second term of equation (2) should be discussed in the review process.

Occupancy (Persons per household) assumptions:

- *Constant rate or demographically driven PPH*: The conservative approach would be to rely on the constant PPH rate assumption or the use of PPH rates by type and rely on the changing composition of total occupied housing. The spatial demography approach is the most theoretically appealing but the data demands are prohibitive under the current time-line and budgetary constraints. The demographic regression approach is intuitively appealing on one level but theoretical and methodological drawbacks are severe. Of all the options, the use of PPH by type and relying on the projections of occupied housing units by type seems to be the best trade-off between predictive power and theory at the current time.

- *Assumptions on fertility schedules and convergence*: In the demographically driven approach the fertility schedules used for the foreign born and the assumed rate of convergence should be subject to review and tested for sensitivity to the rates chosen.

B-1-3. No Project Demographic Forecast

POPULATION

Recent Trends

- Between 2000 and 2003, the region has added 923,000 people.
- By 2003, the regional population is 300,000 higher than SCAG Trend Projection.
- The major component of the recent fast growth is domestic migration. The annual average domestic migration during the period of 1990-2000 was –150,000, but the recent annual average of domestic migration is +39,000.
- The recent trends of other components of growth including the births, deaths, and net immigration is in line with the trend projection.
  - The natural increase has slowed down due to the declining births since 1990. The annual births of 1990-1991 were 328,000, but the annual births of 2002-2003 were 268,000.
  - Net immigration has been stable and has leveled off since 1996.

Recent Trends of Population (in Thousands)

	4/1/2000*	1/1/2001	1/1/2002	1/1/2003	2000-2003
Census/DOF	16,516	16,764	17,110	17,439	923
Trend Proj.	16,516	16,684	16,909	17,133	617
Diff (Trend Proj. – Census/DOF)		-80	-201	-306	
% Diff		-0.5%	-1.2%	-1.8%	

* 2000 Census

2010

- The positive net domestic migration will become negative due to the slow employment growth and the relatively high unemployment rate.
- During 2003-2010, annual population growth will decrease from 335,000 (2000-2003) to 240,000 (2003-2010) (71% of 2000-2003 annual average growth).
- The projected annual average population growth of 240,000 between 2003-2010 is more than that of 190,000 between 1990-2000.
- 2010 population estimate: 19.2 million
- 480,000 (2.6%) more than the Trend Projection and Local Input.
- 2010 county distribution: Local Input

2030

- Kept the growth pattern of Trend Projection between 2010 and 2030.
- Maintained the increasing pattern of employment to population ratio from 2.19 in 2010 to 2.25 in 2030.
- 2030 population projection: add 480,000 to 2030 Trend Projection. (Add 1,125,000 to 2030 local input.)
- Annual population growth will decrease from 240,000 (2003-2010) to 183,000 (2010-2030).

- 2030 population estimate: 22.9 million, which is 480,000 (2.1%) more than Trend Projection, and 1.1 million (5.2%) more than Local Input.
- 2030 county distribution: Local Input

HOUSEHOLDS

Recent Trends

- Between 2000 and 2003, the region added 135,000 households.
- By 2003, the regional household is 101,000 lower than the SCAG Trend Projection.
- The recent slow growth is due to the lower household formation level and the slow housing construction.
- The annual average household growths during 1990-2000 and 2000-2003 were 45,000 and 49,000, respectively.
- The recent housing permit activity is stronger than the recent household growth. Annual average residential building permits and housing growths during 2000-2003 were 70,000 and 53,000, respectively. The most difference between residential building permits and housing growth might have been absorbed into the market to make up for the demolished housing units.

Recent Trends of Households (in Thousands)

	4/1/2000*	1/1/2001	1/1/2002	1/1/2003	2000-2003
Census/DOF	5,386	5,418	5,468	5,521	135
Trend Proj.	5,386	5,450	5,536	5,622	236
Diff (Trend Proj. –Census/DOF)		32	68	101	
% Diff		0.6%	1.2%	1.8%	

* 2000 Census

2010

- Reflect the declining household formation level (109,000). Removed the convergence assumptions that the Asian/Hispanic population will gradually increase its 2000 headship rates toward the White headship rates in 2000 (61,000).
- During 2003-2010, annual household growth will increase from 49,000 (2000-2003) to 70,000 (2003-2010).
- The projected annual average household growth of 74,000 between 2003-2010 is higher than that of 45,000 between 1990-2000.
- 2010 household estimate: 6.04 million
- 170,000 (2.7%) lower than the Trend Projection and 65,000 (1%) lower than Local Input.
- 2010 county distribution: Local Input

2030

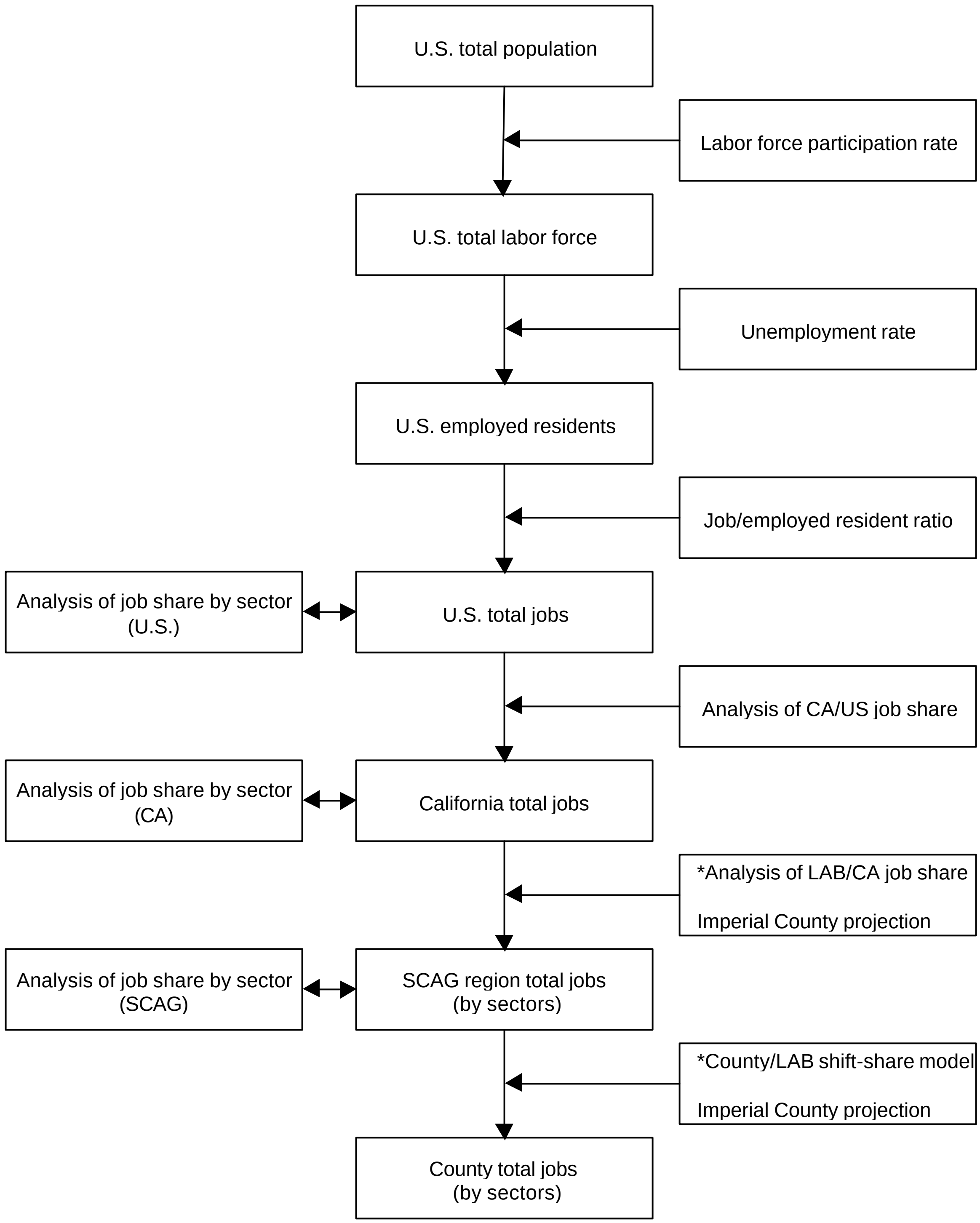
- Maintained the household reduction of 109,000 between 2000-2010 for 2010-2030 due to the lower headship rates.

- Removed the convergence assumptions that the Asian/Hispanic population will gradually increase its 2000 headship rates toward the White headship rates in 2000. Households to be reduced: 61,000 (2010) and 284,0000 (2030).
- Population to household ratio will increases from 3.07 in 2000 to 3.17 in 2010, then decrease to 3.06 in 2030.
- 2010-2030 household: reduce 393,000 from Trend Projection.
- Annual household growth will be maintained at 70,000 (2010-2030).
- 2030 household estimate: 7.5 million, which is 393,000 (5%) lower than Trend Projection, and 155,000 (2%) higher than Local Input.
- 2030 county distribution: Local Input

B-2. Employment Forecast Methodology

B-2-1. Regional and County Employment Trend Projection

Regional and County Employment Projection Process



*LAB (L.A. Basin): SCAG Region excluding Imperial County.

Key Assumptions for Regional No Project Employment Projections

U.S. Overall Labor Force Participation Rate (age 16+)

- 2000: 0.672
- 2010: 0.675
- 2020: 0.660
- 2025: 0.651
- 2030: 0.643
- 2040: 0.634

The BLS 2010 labor force participation rates (from the 11/01 projection set) are used for the 16-54 age groups and extend through the year 2040. The BLS 2010 labor force participation rates for the 55-64, 65-74 and 75+ age groups were raised until 2025 and then kept constant until 2040. The overall participation rate declines from 67.5% in 2010 to 63.4% in 2040 as a result of the aging of the population.

U.S. Unemployment Rate

- 2000-2040: 4%

It is assumed that the equilibrium unemployment rate would remain at the year 2000 rate of 4%.

U.S. Total Jobs to Employed Residents Ratio

- 2000: 1.0502
- 2010-2040: 1.0704

Methodology and Key Assumptions for Preliminary Regional Trend Employment Projections

Summary

The trend employment projection for the SCAG region utilizes a top down procedure starting with a U.S. forecast, followed by California, and finally the SCAG region. In this summary, jobs and employment are used interchangeably. The employment projection will interact with the SCAG regional population forecast.

National Projections

The first step is to project the U.S. labor force based on projections of total population and labor force participation rates. Total jobs are projected from total labor force, unemployment rate, and the ratio of total jobs to employed residents. Total jobs are then projected to a one-digit industry code based on historical trends of the one-digit shares of U.S. total jobs.

- Data Sources
  - The population projections from the Census Bureau Middle Series
  - New BLS (Bureau of Labor Statistics) job projections to 2010
  - BLS labor force participation rates
  - DRI/WEFA (Data Resources International/Wharton Economic Forecasting Associates) data: jobs by one-digit SIC and labor force participation rates
  - REMI (Regional Economic Models Inc.) model U.S. forecast

- Key Assumptions
  - Labor force participation rate
  - Unemployment rate
  - The ratio of total jobs to employed residents

2. California Projections

California total jobs for each forecast year are projected based on U.S. total jobs and the job share of California to U.S. for each forecast year. Total jobs are then projected to the one-digit industry code based on historical trends in the one-digit shares of California total jobs.

- Data Sources
  - Historical job data for the U.S. from BLS
  - Historical data from California EDD (Employment Development Department)
  - U.S. total jobs for each forecast year (SCAG projection)

3. SCAG Projections

Due to its uniqueness in terms of industries and location, SCAG will create a separate forecast model for Imperial County. The regional projection (for the Los Angeles Basin) includes five counties: Los Angeles, Orange, Riverside, San Bernardino, and Ventura.

The procedure for the regional jobs projection is similar to the California jobs projection. Regional total jobs for each forecast year are projected based on California total jobs and the job share of the SCAG region to California for each forecast year. Total jobs are then projected to a one-digit industry code based on historical trends in the one-digit share of SCAG regional total jobs.

Data Sources

- Historical data from California EDD
- California total jobs for each forecast year (SCAG projection)

Methodology

This document describes the methodology, key assumptions and equations for the SCAG regional trend employment projection. The projection utilizes a top down procedure: starting with a U.S. forecast followed by California, and finally the SCAG region.

1. U.S. Total Jobs

Total U.S. jobs are the result of projections of: 1) total U.S. population; 2) labor force participation rates; 3) long-range unemployment rates; and 4) the ratio of total jobs/employed residents, which is an indication of the trend of number of jobs per worker.

1.1 Total Population

The existing Census Bureau 2000 population projections were published in early 2000 before the 2000 Census results were released. The 2000 Census found approximately six million (281.4 million) more residents than had been anticipated for 2000 in the existing projections (275.3 million). The Bureau will prepare new 2000 estimates in 2002, but publication is not likely until the end of the year.

According to the most recent Census Bureau estimate[1], the U.S. population in 2000 is 281.8 million, which is 0.34 million higher than the initial Census 2000 count (281.4 million). It is assumed that this additional increment of growth would continue through 2040 and therefore the Census Bureau Middle Series growth rates are adjusted accordingly. Based on these assumptions, the total U.S. population would reach 354 million in 2025 and 400.6 million in the year 2040.

1.2 Labor Force Participation Rates

The BLS 2010 labor force participation rates (from the 11/01 projection set) are used for the 16-54 age groups and extended through the year 2040. The BLS 2010 labor force participation rates are raised until 2025 for the 75+ age group, and 2030 for the 55-64 and 65-74, and then kept constant until 2040.

Even with significant increases in labor force participation rates for age groups 55 and above, the total U.S. labor force participation rate declines after 2010. This is because most labor force growth is in the 55+ age groups due to the aging of the baby boom population group whose oldest members will turn 55 in 2002. Since the participation rates for the 55+ age groups are so much lower than for younger groups, the movement of the U.S. population into older age groups places downward pressure on the overall labor force participation rate. The overall participation rate declines from 67.5% in 2010 to 63.4% in 2040 as a result of the aging of the population.

The labor force is computed as follows:

[1] based on the demographic analysis released by the Census Bureau on 10/13/01—the ESCAP II report.

$$LF_{(a,y)} = POP_{(a,y)} \times LFPR_{(a,y)}$$
$$LF_{(y)} = \sum_{a} LF_{(a,y)}$$

where

$LF_{(a,y)}$ = labor force by age cohort a, in year y
$POP_{(a,y)}$ = adjusted census population by age cohort a, in year y
$LFPR_{(a,y)}$ = labor force participation rate by age cohort a, in year y

1.3 Total Jobs

It is assumed that the equilibrium unemployment rate would remain at the year 2000 rate of 4%. The projected equilibrium rate reflects the potential for full employment. There is no reason to expect that the unemployment rate will change over the next 40 years.

The TJ/ER (total job to employed resident) ratio through 2010 projected by BLS was lowered by adjusting the labor force for the higher 2000 population estimates (BLS used Census Middle Series data). The 2010 TJ/ER rate was held constant to 2040.

There is a sharp drop in job growth rates after 2010 as labor force growth slows down. The growth rate for U.S. total jobs drops from 1.4% per year between 2000 and 2010 to 0.6% between 2010 and 2020. National job growth rates remain in this range until 2040.

Total U.S. jobs are computed as follows:

$$ER_{(y)} = LF_{(y)} \times (1 - UE_{(y)})$$
$$JOB_{(y)} = ER_{(y)} \times (TJ / ER)_{(y)}$$

where

$ER_{(y)}$ =employed residents in year y
$UE_{(y)}$ = unemployment rate in year y
$JOB_{(y)}$ = job estimate in year y
$(TJ / ER)_{(y)}$ = the ratio of total jobs to employed residents in year y

2. California Total Jobs

2.1 2010 Job Projection

The short-term projection to 2010 is based on CCSCE's (Center for the Continuing Study of the California Economy) California job projection model using updated projection factors based on revised 2000 and preliminary 2001 job data.

2.2 2015-2040 Job Projection

Several sets of California shares of U.S. job growth are calculated. The 1996-2001 CA/U.S. share is used for the 2015-2025 projection, and the 1979-2010 CA/U.S. share is used for 2030-2040 projection. The California job is calculated as follows:

$$CA_{y2} = CA_{y1} + [(U.S._{y2-y1}) \times SHARE_{ab}]$$
$$SHARE_{ab} = \frac{CA_b - CA_a}{U.S._b - U.S._a}$$

where

CA_{y2} = California jobs to be estimated in year y2

CA_{y1} = California jobs in year y1

$U.S._{y2-y1}$ = U.S. job growth from year y1 to y2

$SHARE_{ab}$ = California share of U.S. job growth from year a to b

Annual state job growth slows dramatically from 380,000 per year for 2000-2010 to below 200,000 per year after 2010. The state's share of U.S. jobs continues to rise, but more slowly after 2010.

3. SCAG Region Total Jobs

Similar to the California job projection, 2010 total jobs are projected by CCSCE's LAB (LA Basin which is the SCAG region excluding Imperial County) job projection model. For the job projection between 2015 and 2040, the LAB/CA growth shares are analyzed and projected and LAB total jobs are projected from CA total jobs in the same manner as CA jobs are projected from U.S. jobs above. Since this job projection does not include Imperial County, the SCAG staff has created a separate forecast model for Imperial County. The 1999-2010 LAB/CA share is used for the 2015-2040 projection

LAB jobs are calculated as follows:

$$LAB_{y2} = LAB_{y1} + [(CA_{y2-y1}) \times SHARE_{ab}]$$
$$SHARE_{ab} = \frac{LAB_b - LAB_a}{CA_b - CA_a}$$

where

LAB_{y2} = LAB jobs to be estimated in year y2

LAB_{y1} = LAB jobs in year y1

CA_{y2-y1} = California job growth from year y1 to y2

$SHARE_{ab}$ = LAB share of California job growth from year a to b

4. Issues for Further Analysis

The following additional analysis needs to be completed over the next three months in order to improve the regional employment projections:

- The revised regional 2000 and 2001 employment data needs to be obtained from EDD when it is available. These data will indicate 1) the severity of the current downturn and 2) whether the LAB/CA shares have changed dramatically as may have occurred in the 1999-2001 period.

- The regional labor force participation rates and the regional labor force need to be carefully projected. It is important to evaluate the difference in age composition and labor force participation rate between the SCAG region and the United States. It is possible that a younger and larger labor force may be a competitive advantage for job growth.

- It is necessary to get feedback on U.S. population growth, national labor force participation rate trends, and the TJ/ER ratio.

- It may be more difficult to balance population and jobs in a period of rapidly slowing job growth. This trend makes it more important to get labor force participation rates accurate for the region versus the nation. This is because small errors will magnify the required population to match job growth – either upward or downward.

- Major changes in regional population and household growth can occur with modest changes in job levels as retirement becomes more of a factor. These trends will require careful explanation or it will look as if the job and population trends are not consistent.

Methodology and Assumptions for Preliminary County Trend Employment Projections

This document describes the methodology, assumptions, and equations for the SCAG county employment trend projection. The projection utilizes a shift-share model for short-term projection by industries to 2010. A county to SCAG region growth share method is utilized for the long-term total employment projection (2015-2040).

1. Short Term Projection – through 2010

The short-term employment projection to 2005 and 2010 is based on CCSCE's (Center for Continuing Study of the California Economy) job projection model (shift-share model) using updated projection factors based on revised 2000 job data.

1.1 Metropolitan Area Employment Projection

SCAG staff and consultant utilized the shift-share model to project 2010 employment for each of the four metropolitan areas of SCAG region: Los Angeles, Orange, Riverside-San Bernardino, and Ventura.

1.1.1 Data Source

- Employment data: California EDD (Employment Development Department) & CCSCE
  - Data from 1979 to 2000
  - Includes four metropolitan statistical areas (MSA) as mentioned above. We use Los Angeles Basin (LAB) to represent the four MSAs in this document.
  - Includes 92 industries, 23 of them are aggregated from combinations of the 69 industries
  - The self-employed estimates are from CCSCE
  - Los Angeles Basin employment is projected by CCSCE
- Metropolitan area and regional population: California Department of Finance.

1.1.2 Methodology and Assumptions

There are five industry projection methodologies used in the SCAG metro area. Each of the 69 separate industry projections are developed on an individual basis.

a. A specified MSA share of LAB population growth (POP GROWTH)
b. A specified MSA share of projected LAB job growth (INCREMENT)
c. Average Share (MSA/LAB) for a specified historical period (e.g., 1994-00AVG)
d. A specified annual change in the MSA/LAB share (CHG IN SHARE)
e. Most recent MSA/LAB share (2000 SHARE)

A. A specified MSA share of LAB population growth (POP GROWTH)

The underlying theory is that job growth in these industries is related to population growth. This methodology is used for non-basic – i.e., population-serving industries. In the shift-share model, 11 industries are projected using the POP GROWTH methodology for all four metro areas:

Local Transit
Travel Services
Retail Trade
Real Estate
Personal Services
Auto & Misc. Repair
Theaters & Video Stores
Health Services
Social Service, Membership Organizations
Local Government
Local Education

In 2000, these industries accounted for 38.1% of LAB jobs. The population growth methodology was selected for these industries because they followed population growth trends in the historical period. We used the 2000-2010 MSA share of LAB population growth as the projection share of regional job growth.

The population growth was calculated as follows:

$$PG_{(MSA)} = \frac{POP_{(MSA,2010)} - POP_{(MSA,2000)}}{POP_{(LAB,2010)} - POP_{(LAB,2000)}}$$

where

$PG_{(MSA)}$ = MSA share of LAB population growth from 2000 to 2010
$POP_{(MSA,2010)}$ = MSA population in 2010
$POP_{(LAB,2010)}$ = LAB population in 2010

Once population growth was calculated, the employment was calculated as follows:

$$E_{(MSA,y)} = E_{(MSA,2000)} + (E_{(LAB,y)} - E_{(LAB,2000)}) \times PG_{(MSA)}$$

where

$E_{(MSA,y)}$ = MSA employment in project year y
$E_{(LAB,y)}$ = LAB employment in project year y

B. A specified MSA share of projected LAB job growth (INCREMENT)

This methodology develops a metro area industry job projection by projecting that the metro area will receive a specified share of the regional job growth (i.e., increment). We used the 1979-2000 MSA/LAB share of job growth as the projection share of regional job growth.

The increment method is generally used for "basic" industries, i.e., industries where jobs can locate in any metro area within the region. The definition of basic industries is broader at the metro area level than at the regional or state level. Some industries, like Finance, which are primarily population serving at the regional level, have a strong basic component for metro areas within the region.

The increment method allows MSA/LAB shares to change over time as the "increment" share is rarely the same as the current share. Conditions when the methodology is suitable include:

- The industry is relatively large
- The industry has substantial positive job growth in both the historical and projection period
- The MSA had a plausible share of regional growth in the historical period.

For Los Angeles County, eight industries met these criteria:

Self-employed
Hotels
Computer Services
Other Business Services
Amusements
Legal Services
Educational Services
Engineering and Management Services

In 2000, these eight industries accounted for 23.9% of LAB jobs.

The 1979-2000 MSA/LAB shares of incremental regional job growth was calculated as follows:

For each industry:

$$INC_{(MSA)} = \frac{E_{(MSA,2000)} - E_{(MSA,1979)}}{E_{(LAB,2000)} - E_{(LAB,1979)}}$$

where

$INC_{MSA)}$ = MSA/LAB increment share from 1979 to 2000

$E_{(MSA,2000)}$ = MSA employment in 2000

$E_{(LAB,2000)}$ = LAB employment in 2000

The employment was then calculated as follows:

$$E_{(MSA,y)} = E_{(MSA,2000)} + (E_{(LAB,y)} - E_{(LAB,2000)}) \times INC_{(MSA)}$$

where

$E_{(MSA,y)}$ = MSA employment in project year y
$E_{(LAB,y)}$ = LAB employment in project year y

C. Average Share (MSA/LAB) for a specified historical period (AVG SHARE)

The historical average share methodology is normally used when the MSA/LAB industry job share has been relatively constant, the INCREMENT method is not suitable and it is reasonable to assume that the MSA/LAB share will not change. It is normally assumed that the historical average share will continue because there is rarely specific information to the contrary.

There are 30 industries where the historical average share methodology was used for Los Angeles County.

Farming	Shipbuilding	Communication
Mining	Other Transp. Equip.	Film Production
Construction	Search & Navig. Instr.	Agric. Services
Logging	Meas. Control Instr.	Other Fed/Govt.
Other Wood Products	Medical Instruments	State Govt.
Printing and Publishing	Other Instruments	State Education
Petroleum	Misc. Manufacturing	
Leather	Railroads	
Prim. Metal Prod.	Trucking	
Fabr. Metal Prod.	Water Transp.	
Computers	Air Transp.	
Other Ind. Mach.	Pipeline Transp.	

These 30 industries accounted for 19.5% of LAB jobs in 2000.

We used the 1994-2000 period as the relevant historical period to examine whether MSA/LAB shares were relatively constant. First, it is the most recent period. Second, the region went through a significant one-time shock in adjusting to defense downsizing and the MSA/LAB shares prior to 1994 were in a period of adjustment.

There are three criteria used in selecting this share projection methodology. First is where the share has been constant throughout the time period – e.g., Printing. Second is when MSA/LAB shares have fluctuated up and down without a clear pattern – e.g., Petroleum. Third is when it is thought that the share will move back to a higher or lower level – e.g., Fabricated Metal Products. There were several cases for Los Angeles County where a choice had to be made as to whether the share decline would continue or reverse because Los Angeles lost such a large share between the late 1980s and 1994.

The 1994-2000 (inclusive) average share was calculated as follows:

$$A\_SHARE_{MSA)} = \frac{\sum_{t=1994}^{2000} SHARE_{(MSA,t)}}{7}$$

where:

$A\_SHARE_{(MSA)}$ = MSA average share
$SHARE_{(MSA,t)}$ = MSA share of LAB employment in year t between 1994 and 2000.

The employment was then calculated as follows:

$$E_{(MSA,y)} = E_{(MSA,2000)} + (E_{(LAB,y)} \times A\_SHARE_{(MSA)})$$

where

$E_{(MSA,y)}$ = MSA employment in project year y
$E_{(LAB,y)}$ = LAB employment in project year y

D. A specified annual change in the MSA/LAB share (CHG IN SHARE)

The change in share methodology is normally used when the MSA had job losses while the region had job gains (or vice versa) and in situations where the MSA/LAB share has steadily increased or decreased and the INCREMENT methodology is not suitable. In the SCAG region, this usually occurs when production facilities in an industry are steadily decentralizing from Los Angeles County to other regional locations. An example of this situation is Textiles and Apparel.

There are 17 industries where the change in share methodology was used for Los Angeles County.

Other Food Products	Other Electric Equip.
Textiles	Motor Vehicles
Apparel	Aircraft
Furniture	Utilities
Paper	Wholesale Trade – Dur.
Chemicals	Wholesale Trade – NonDur.
Plastics, Rubber Prod.	Finance
Stone, Clay & Glass	Insurance

Electronic Equip.

These 17 industries accounted for 17.9% of LAB jobs in 2000.

We used the 1979-2000 period for calculating average annual share changes. We used 0.5 multiply the historical CHG IN SHARE for the projections. This decision has the effect of slowing the projected share change relative to the historical pattern. The main reason is that the historical period includes a major one-time adjustment for MSA in the early 1990s which we do not expect to be repeated.

The change in share was calculated as follows:

$$C\_SHARE_{(MSA)} = \frac{SHARE_{(MSA,2000)} - SHARE_{(MSA,1979)}}{21}$$

$$SHARE_{(MSA,y)} = SHARE_{(MSA,2000)} + (y - 2000) \times 0.5 \times C\_SHARE_{(MSA)}$$

where:

$C\_SHARE_{(MSA)}$ = change in MSA/LAB share between 1979 and 2000
$SHARE_{(MSA,2000)}$ = MSA share of LAB employment in 2000
y = project year

The employment was then calculated as follows:

$$E_{(MSA,y)} = E_{(MSA,2000)} + (E_{(LAB,y)} \times SHARE_{(MSA,y)})$$

where

$E_{(MSA,y)}$ = MSA employment in project year y
$E_{(LAB,y)}$ = LAB employment in project year y

E. Most recent MSA/LAB share (2000 SHARE)

In rare cases the historical share pattern is very difficult to interpret. A fallback methodology is to utilize the most recent MSA/LAB share (in this case for 2000) is used.

For Los Angeles County, three industries – Preserved Fruits and Vegetables, Missiles/Space and Federal Defense – were projected using the 2000 share. These three industries accounted for 0.5% of LAB jobs in 2000.

The employment was then calculated as follows:

$$E_{(MSA,y)} = E_{(MSA,2000)} + (E_{(LAB,y)} \times SHARE_{(MSA,2000)})$$

where

$E_{(MSA,y)}$ = MSA employment in project year y
$E_{(LAB,y)}$ = LAB employment in project year y
$SHARE_{(MSA,2000)}$ = MSA share of LAB employment in 2000

1.1.3 Metropolitan Area Total Employment

Once projection for each of 69 industries for each MSA was completed, the employment by each MSA was normalized to LAB employment by each industry. Total employment for each MSA was then aggregated.

1.2 Riverside – San Bernardino Split

The following procedure is to split Riverside and San Bernardino Counties from the Riverside-San Bernardino metropolitan area. The reason that we did not include the two separate counties in the shift-share model is because the employment data is only available for each county beginning in 1988.

1.2.1 Data Sources

- Employment data: California EDD (Employment Development Department) & CCSCE
  - From 1988 to 2000
  - Includes 44 industries, total employment is aggregated from combinations of the 43 Industries
- Metro area and regional population: California Department of Finance.

1.2.2 Methodology and Assumptions

The procedure to distribute the MSA employment to the county is similar to the region to MSA procedure. The historical county/MSA share trends were analyzed one of the five MSA projection methodologies – average share, change in share, share of increment, 2000 share, or population growth was selected.

2. Long Term Total Employment Projection – 2015 - 2040

For the employment projection between 2015 and 2040, the County/LAB employment growth shares were analyzed. Several sets of SCAG county shares of LAB job growth are calculated. The 1979-2010 County/LAB share was used for the 2015-2040 projection.

$$SHARE_{(c)} = \frac{E_{(c,2010)} - E_{(c,1979)}}{E_{(LAB,2010)} - E_{(LAB,1979)}}$$

where

$E_{(c,2010)}$ = County c total employment in 2010
$E_{(LAB,2010)}$ = LAB total employment in 2010
$SHARE_{(c)}$ = County c share of LAB employment growth between 1979 and 2010

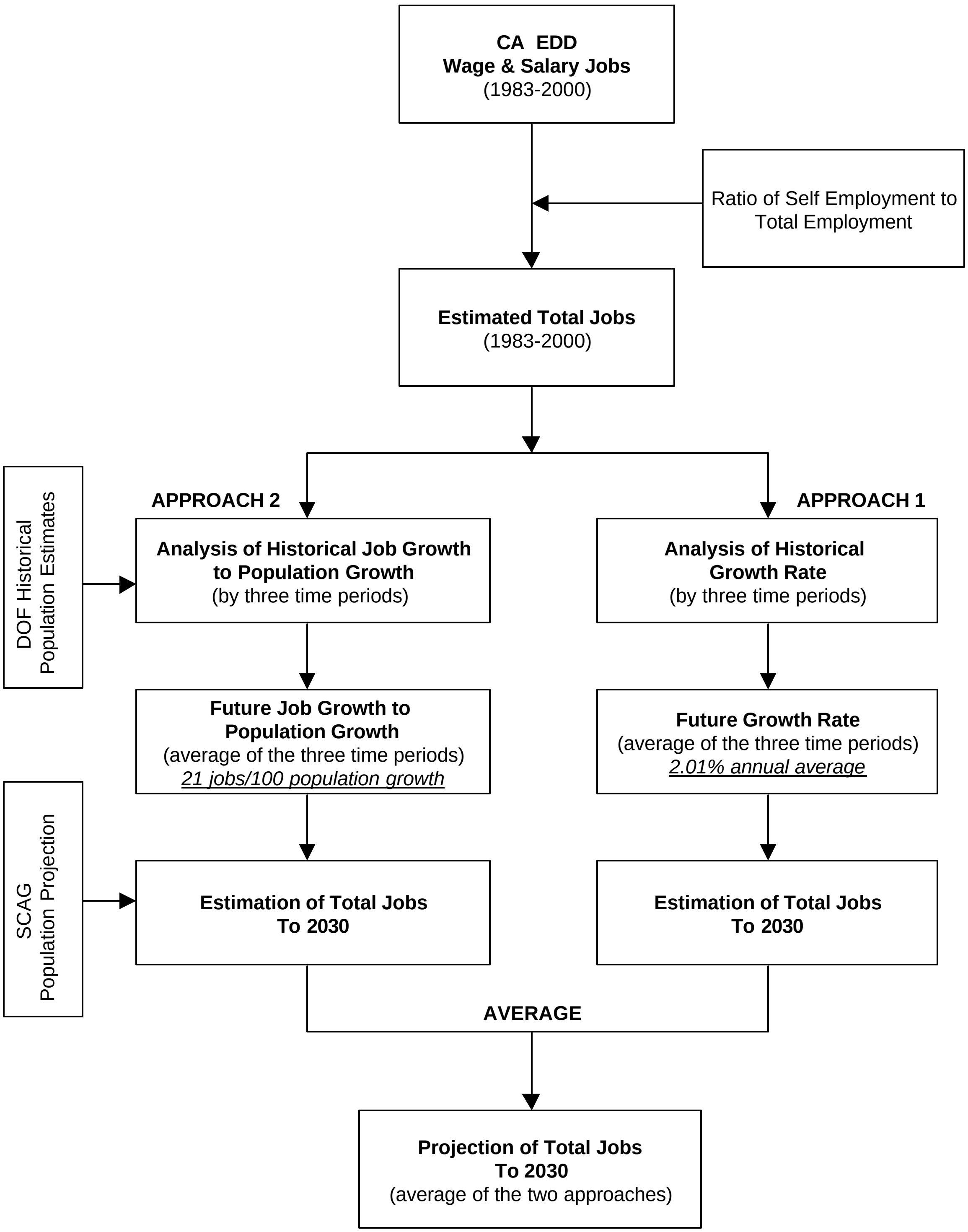
$$E_{(c,y)} = E_{(c,2010)} + [(E_{(LAB,y)} - E_{(LAB,2010)}) \times SHARE_{(c)}]$$

where

$E_{(c,y)}$ = County c total employment in project year y
$E_{(LAB,2010)}$ = LAB total employment in 2010

3. Employment Trend Projection for Imperial County

Employment Trend Projection For Imperial County



EMPLOYMENT TREND PROJECTION FOR
IMPERIAL COUNTY

Due to the uniqueness of its geographic location and economic structure, the SCAG shift-share model does not include Imperial County. SCAG has created a separate projection procedure for Imperial County. This document provides the procedures, assumptions, and methodology for job projections for Imperial County. The job projection will be used for the SCAG 2004 RTP. The data, methodology, and procedure will be improved when updated information is available.

Data

1. Wage and salary jobs: Historical data from California Employment Development Department (EDD).
2. Population projection from California Department of Finance (DOF)
3. Self-employment ratio (self-employed jobs to total jobs): the ratio of LA Basin[2] self-employment provided by Center for the Continuing Study of the California Economy (CCSCE) was used.

Assumptions

3. The year 1999 was used as the basis to project jobs for forecast years. Wage and salary jobs in 2000 are lower than 1999 (600 less than 1999).
4. Self-employment ratio (self-employed jobs to total jobs): use the ratio for the LA Basin provided by CCSCE.

Procedure

1. Compute total employment for 1983-1999 based on EDD wage & salary data and self-employment ratio for LA Basin from CCSCE. Total jobs are computed as follows:

$$JOB_a = {WS_a}/{(1 - R_a)}$$

where

JOB_a = Total jobs to be estimated in year a

WS_a = Wage & salary jobs in year a

R_a = Self-employment ratio in year a

[2] Five SCAG counties: Los Angeles, Orange, Riverside, San Bernardino, and Ventura.

2. Two different approaches are used to project future jobs

2.1 Approach 1: Job Growth Rate

- Annual growth rates (compound rate) for each year to 1999 are calculated. The growth rates are calculated based on wage and salary data, starting from 1983.
- Calculate average growth rate for three time periods:
  - 1983-1999 (2.14%): EDD data start from 1983
  - 1990-1999 (1.88%): Beginning of recession
  - 1995-1999 (2.01%): 1994 data are excluded because it is extremely low (1.05%), compared to other years.
- Calculate the average rate for the three periods as the final annual average growth rate, which is 2.01%
- Total jobs in forecast year are calculated as follows:

$$JOB_y = JOB_{1999} \times (1 + 2.01\%)^{(y-1999)}$$

where

JOB_y = Total jobs in forecast year y

JOB_{1999} = Total jobs in 1999

2.2 Approach 2: Job Growth to Population Growth

- It is assumed that the job increase in Imperial County is related to population growth.
- Calculate the ratio of job growth to population growth for three time periods: 1983-1999 (31.5%), 1990-1999 (17.7%), and 1994-1999 (13.9%). The ratio is calculated as follows:

$$RATIO_{ab} = (JOB_b - JOB_a) \big/ (POP_b - POP_a)$$

where

$RATIO_{ab}$ = The ratio of job growth to population growth from year a to year b

JOB_a = Total jobs in year a

JOB_b = Total jobs in year b

POP_a = Total population in year a

POP_b = Total population in year b

- Calculate the average of the three periods as the final ratio, which is 21%
- Total jobs in forecast year are calculated as follows:

$$JOB_y = JOB_{1999} + (POP_y - POP_{1999}) \times 0.21$$

where

JOB_y = Total jobs in forecast year y

JOB_{1999} = Total jobs in 1999

POP_y = Total population in year y

POP_{1999} = Total population in 1999

3. Final Projection

- Calculate the average total jobs projected by the two approaches from 2-1 and 2-2. The final results are shown in the following table.

B-2-2. Sub-County Employment Trend Projection

James Dulgeroff, Ph.D.
Information Decision Sciences Department
California State University, San Bernardino

June 26, 2002

Prepared for Southern California Association of Governments

Introduction

The paper summarizes a regional employment allocation model, which distributes employment projected for the SCAG region, among 200 cities and unincorporated areas. It generates city-level employment projections, by five-year increments, from 2000 to 2030. The model is linked directly to inputs derived from two sources:

• Model input population values from the Population and Household Projection for Cities and Sub-regions. The methodological framework inputs the population derived from city-level projections. Thus, employment growth will be consistent with population projections.

• County-level control totals for employment by economic sector. For the purposes of the sub-regional employment projection, the methodology requires that the allocation of employment by sector be consistent with control totals input from SCAG's adopted county employment trend projection for five-year increments.

The methodology outlined below will utilize inputs from both of the modules listed above. The projection model developed here will input changes in population at the city-level, or any changes for county employment, by retail, service, and other employment sectors needed for the trend projection. Such changes may be quickly input and new city-level and sub-regional employment totals derived. This characteristic is highly desirable, given that the population forecasts may change, with staff feedback on the modeling results, or with a local review process. The approach allows such changes in city population, or county controls in employment to be applied, and new employment allocations instantaneously generated. While the model is simple, its predictive power is robust.

Model Assumptions

The methodology utilized here is standard in small-area, regional employment allocation models associated with urban planning. The model relies on developing a distance decay measure of market potential for employment. Preliminary regression results indicate that a lagged employment term adds stability and reliability to the model's predictive power. The development of the model has relied, also, on the results of earlier empirical work (correlation and regression analysis on available time-series data for the SCAG region). Thus far, empirical testing validates several hypotheses:

- The amount of employment in a city is directly proportional to the spatial distribution of the markets for that type of employment in and around the city.
- SCAG's transportation database is a useful source of information on the distance decay associated with existing employment centers. These centers, in effect, pull workers to larger job centers, in inverse proportion to the distance, or time it takes a worker to reach any given employment center.
- Agglomeration effects are an important determinant of urban form for small-area forecasting in the SCAG region. Because of urban agglomeration, the quantity of local employment activities in a city (j) at the present time (t) is directly proportional to the quantity of local employment which was in the city in the previous time period (t - 1). This assumption adds

stability to the model by assuming that a city's regional specialization, or comparative advantage, will continue into the future.

Agglomeration refers to economies of scale that arise from the spatial complementarity of economic activities in close proximity to one another. For example, we see more sewing machine repair shops near the Los Angeles garment district, or more rental car facilities near airports. Related to non-basic activities, we see the existence of large shopping malls, local retail strips, and business parks. Likewise, medical offices are often located near hospitals.

The allocation of employment across the cities and unincorporated sub-regions of SCAG is nested, in that it assumes that employment by industrial sector is determined exogenously at the County level. This procedure assumes that questions of firm, or facility location in one county versus another have already been dealt with in the County Employment Projections. That model was a shift-share approach from California employment totals, down to the six counties of the SCAG region.

The effects of SCAG region-wide growth or decline in employment have been addressed, and are not dealt with in the sub-regional spatial allocation module. The question of intra-regional, city employment allocation is of the following type:

Given the SCAG employment projection, by sector within each county, where will this employment be allocated across the cities, at the sub-county level?

Regional and urban modelers often rely on distance decay relationships to distribute jobs across urban space; such a "journey to work" model is utilized here.

Modeling Procedures

The following is a brief step by step narrative of the modeling procedure:

1. **Track historical growth patterns for cities/subregions in the SCAG economy, by sector** (retail, service and manufacturing, other) as it was coming out of the 1990 recession. Perform regression analysis on historical trend 1990 to 2000, tracking the SCAG economy as it comes out of the recession for basic and non-basic industries, by cities within each county. Regression inputs measure a.) market potential and b.) intra-urban agglomeration effects, or market specialization.

2. **Calibrate the model for 1990-2000**, using actual growth in population and actual employment by sector from the SCAG database. Fit the model so as to account for the relative contribution of market potential versus actual size (specialization/agglomeration) of an economic sector existing within each city.

3. **Link Jobs to Population Growth, POP 2000 to 2005**: Forecast labor force by utilizing the projected increase in population, input from the small- area housing/population projection. In turn, the location of workers at residential locations follow a distance decay formulation in which:

a. **The greater a city's relative size, the greater is that city's job market potential.**

b. **A greater distance (or time) journey- to-work reduces a city's ability to pull potential workers to job destinations from other cities.**

4. Calibrate the city employment projection model to meet County Control Totals for Employment in year 2005.

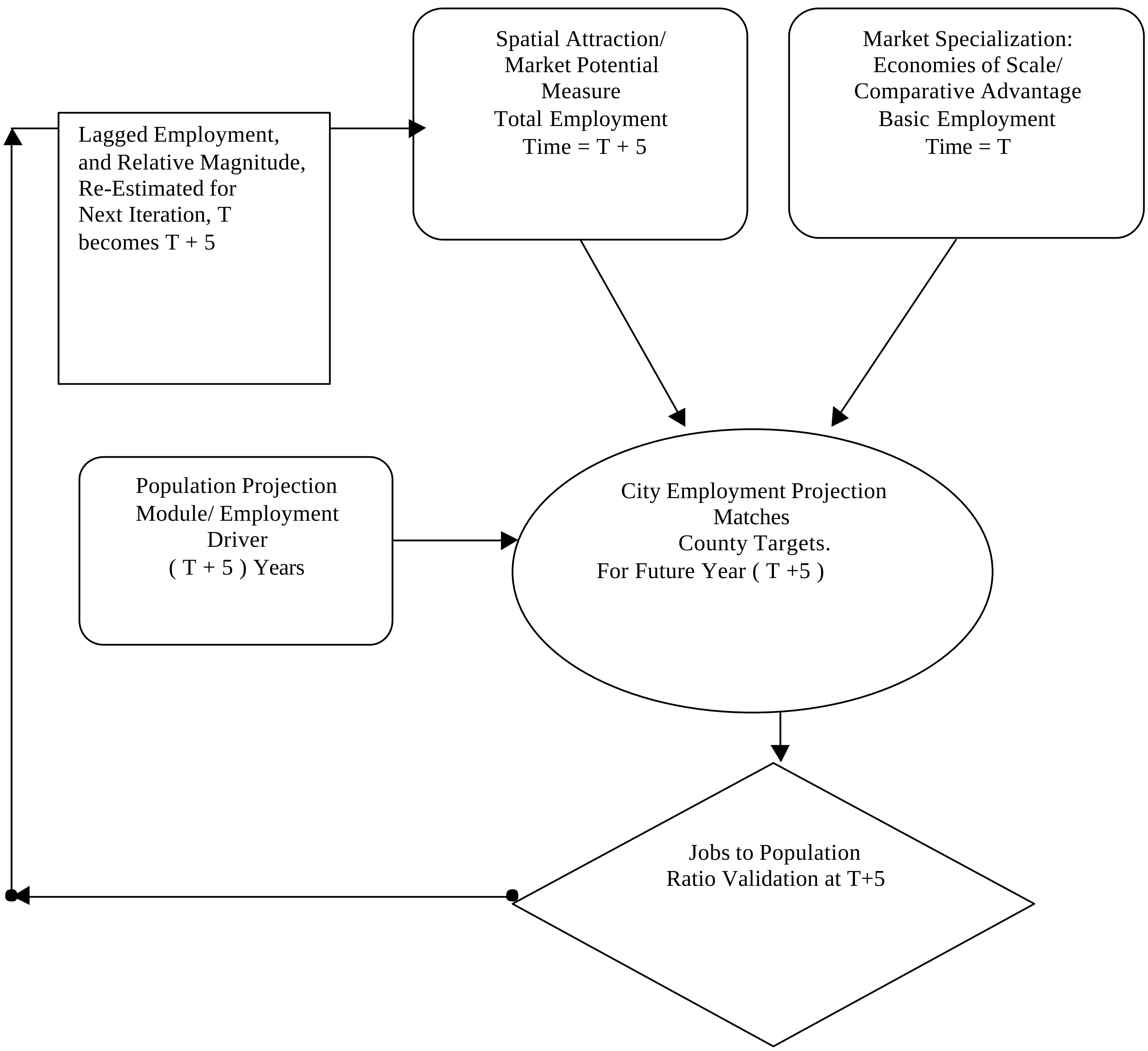
5. **Validation of Jobs to Population ratios, checks consistency of the projection, before moving to the next 5-year iteration.**

6. **Next 5-year Iteration--recalibrate the model using the projected 2010 population, and the 2005 city employment** (checking the output by computing the jobs-to-population ratios, verifying reasonable ratios) to meet the county controls for county-level employment.

Flow Chart

The flow diagram represents the flow of the modeling. Note that projected information is indicated as (t + 5), to distinguish known quantities in the year 2000, denoted as t = baseyear:

Intra-Urban ***E***mployment ***A***llocation ***M***odel (***EAM*-Module**)



Model Specification

The general structure of the model is specified as follows

$$E^{k}_{j,t} = \mathrm{f}\,(M^{k}_{j,t}, E^{k}_{j,t-1}) \qquad (1)$$

where

$E^{k}_{j,t}$ is the employment of type k in city j at time t ,

$M^{k}_{j,t}$ is a measure of the markets for type k goods spatially distributed in and around city j, at time t . The subscript t, for the forecast would be 2005, for the first iteration.

$E^{k}_{j,t-1}$ is the employment of type k in each city j in the previous time period t - 1 .

Each type of employment k will vary in its dependence on the city-level market potential variable (**M**) and /or on the lagged city-level employment variable (**E**) in determining its level in a particular city/subregion. Therefore, it is useful to separate each variable's contribution, by separating these two independent variables. For simplicity, we shall take off the economic sector superscript, with the knowledge that this methodology applies for total employment, as well as the case where economic sectors (e.g., services, retail and other) are projected from known amounts of employment, by sector, in the baseyear. The SCAG region economic projection uses a year 2000 employment base which can be further broken down into retail, service and other classifications for each city and subregion.

There is a practical matter, when the equation estimation is applied to year 2000 data for small-area data, with regard to the relative magnitude of the market variable and the lagged variable. How should these relative magnitudes be weighted? This simple structural form was adopted:

$$Emp_{j,2005} = w_{mkt\_potential} \times M_{j,2005} + w_{specialization} \times Emp_{j,2000} \qquad (2)$$

where the parameters $w_{mkt\_potential}$ and $w_{specialization}$ will indicate the relative importance of the market potential variable (a distance decay formulation) or the lagged (existing) employment-share variable in determining the allocation of city-level employment. These are weights attached to the relative importance of each of the variables. As the project progressed, greater confidence and weight were assigned to the market potential variable, which follows a gravity-type formulation described below; and takes advantage of the transportation database.

In addition, it was helpful to constrain the weighting parameters such that

$$w_{market\_portential} + w_{specialization} = 1 \cdot 0 \qquad (3)$$

This allowed the relative weights of the M and the E terms to be seen directly. In order to prevent the weighting (w) parameters from merely acting as scaling of the variables and possibly masking their weighting effect, it was necessary to scale these variables before their use in equation (2) so that they are of equal magnitudes. Finally, in order to avoid the use of an arbitrary scaling parameter, the scaling of these two variables should result in each of their sums over the SCAG sub-regions, equaling the county total projected for this type of employment in the adopted county-level growth projection, by five -year increments. This form of the model allows the projections to be run, without resort to ad hoc normalization procedures. The output of the model, as specified here, always allocated the county-level jobs added down to the city level, and hit the given control totals exactly.

The final piece necessary to complete the model specification is the spatial distribution of projected population growth, as an indicator of the spatially derived market potential for the basic and non-basic employment in each city. After testing both population growth, and absolute population size, it was found that measuring market potential using the forecast value of population was more reliable.

The final formulation of market potential used an estimate of the Labor Force (**LF**) in each city. Using year 2000 population and workers at place of residence, the known ratio of employed labor force (workers) to population is calculated. Applying this ratio to the population projection for each city, we derive a projected distribution of workers by place of residence. That labor force residing inside each city is denoted as **LF**. Thus, the relative attractiveness of a city for employment, the city's market potential (Mj), is summarized in the following functional form:

$$M_j = \sum_j LF_i \times p_{ij}^m \qquad (4)$$

where LF = represents the total labor force living in zone i , at time t and $p_{ij} = \mathrm{f}\left(hw\_trips_{ij}\right)$

represents the relative attractiveness, or probability related to the market potential of surrounding cities, as measured by actual home–to-work trip behavior. SCAG's origin-destination trip matrix was examined, and an appropriate level of aggregation was determined to calculate the proportion of worktrips originating in any one city and going to all others. These (m zone-to-zone) probabilities could be modified to take account of changing information on the availability of developable land, for each 5-year iteration. In the equation, m represents the fact that this would be an (m x m) matrix of probabilities, with m being the number of cities and unincorporated areas within the SCAG region. Unincorporated areas were disaggregated and controlled (or checked for jobs/population ratios) in the same manner as the cities. The consistency check for job-to-population ratios has exactly m elements. It was desired that the O/D trip matrix aggregation to correspond exactly to this geography, as well (m zone to -zone trips).

In general trip potential is computed by:

$$p_{ij}^m = \frac{trips\_O\_from\_city(i)\_to\_city(j)}{Total\_trips\_from\_city(i)}$$

where *trips_O* means trips produced in city i (city of trip origin), and attracted to city j (city of destination). These probabilities were computed for home-to-work trip data, from the origin-destination (O-D) information in SCAG's transportation database for 1997. To validate this O-D trip table, the known workers for year 2000 were input through the trip table to derive an estimate, for comparison to known year 2000 employment at place of work. The results corroborated the accuracy of the approach.

The worktrip probabilities were derived from an aggregation of the detailed zone-to-zone trip table, comprised of 3191 Transportation Analysis Zones (TAZ's). The table generated millions of zone-to-zone, home-to-work, trips. The destinations of the residential workers were aggregated to the city level.

This section gives more attention to the scaling of variables so as to ensure they meet the control totals. An asterisk replacing a superscript or a subscript denotes summation over that superscript or subscript;

thus, we let $E^k_{*,t}$ be the exogenous county-level forecast of type k employment. The scaled values of the market potential and lagged employment variables have the property that

$$\sum_j \widetilde{M}^k_{j,t} = \sum_j \widetilde{E}^k_{j,t-1} = E^k_{*,t} \qquad (5)$$

The spatial distribution of year 2000 employment is known at t-1. Thus, the year 2005 employment projection involves only jobs added of type k employment. The superscript k represents the economic sector (generally, retail, service and other employment are broken out). Thus, equation (5) should be replaced by

$$\sum_j \widetilde{M}^k_{j,t} = \sum_j \widetilde{E}^k_{j,t-1} = \Delta E^k_{*,t} \qquad (6)$$

where,

$$\Delta E^k_{*,t} = (E^k_{*,t} - E^k_{*,t-1})$$

The scaling may then be accomplished for the markets variable by use of the expression

$$\widetilde{M}^k_{j,t} = M^k_{j,t}\left(\frac{\Delta E^k_{*,t}}{M^k_{*,t}}\right) \qquad (7)$$

and the lagged employment will be scaled in the same manner

$$\widetilde{E}^k_{j,t-1} = E^k_{j,t-1}\left(\frac{\Delta E^k_{*,t}}{E^k_{*,t-1}}\right) \qquad (8)$$

Thus, the form of the original equation (2) becomes

$$\Delta E_{j,t} = w_{market} M_{j,t} \left(\frac{\Delta E_{*,t}}{M_{*,t}} \right) + w_{emp} E_{j,t-1} \left(\frac{\Delta E_{*,t}}{E_{*,t-1}} \right) \qquad (9)$$

where

$$w_{market\_potential} + w_{existing\_specialization} = 1 \cdot 0$$

This formulation should generate city-level projections that match control totals projected for the 6 counties, by each 5-year increment from 2000 to 2005.

It should be noted that most of the weight has been assigned to the market potential variable. The other lagged employment variable's weight would involve allowances for site specific, known development, or would allow cities possessing specialized economic sectors to retain their existing share of a county's growth in that economic sector's projected employment growth. The probabilities, Pij, could be weighted, or be a function of other variables, such as the amount of developable commercial land, or just developable land, in each 5-year iteration.

Because a projected spatial distribution of the population year 2005 = t is given by city from the population projection module, it is possible to generate a market potential variable to estimate employment in 2005 (= t). The population projection drives the estimate of workers at place of residence. This vector of workers, the labor force (LF) at home, is then applied to the trip table to derive a likely city of destination, the place of employment. Applying the detailed home-to-work trip information allows a fairly accurate estimate of the likelihood of living in one city and working in any other sub-regional zone.

Summary Notes on Notation and Sub-County Employment Model Representation

Representing a total employment forecast, across all sectors, the model equations can be rewritten:

$$\Delta Emp_{j,t} = w_{market} M_{j,t} \left(\frac{\Delta Emp_{*,t}}{M_{*,t}} \right) + w_{emp} Emp_{j,t-1} \left(\frac{\Delta Emp_{*,t}}{Emp_{*,t-1}} \right) \quad \textbf{(1)}$$

where,

$$\Delta Emp_{*,t} = (Emp_{*,t} - Emp_{*,t-1})$$

and

$$w_{market\_potential} + w_{existing\_specialization} = 1 \cdot 0$$

The market potential (M) is defined as:

$$M_j = \sum_j LF_i \times p_{ij}^m \quad \textbf{(2)}$$

where M is estimated by applying a distance decay, journey-to-work likelihood function to the workers at place of residence. This residential labor force (LF) then is transitioned through a journey to work matrix to obtain an estimate of employment at each place of work. This is a well-known method for distributing county control totals of employment down to smaller jurisdictions within an urban area.

The basic formulation of the probability for five-year forecast increments is:

$$p_{ij}^m = \frac{trips\_O\_from\_city(i)\_to\_city(j)}{Total\_trips\_from\_city(i)} \quad (3)$$

where trip_O represents city of origin for home to work trips. These trips are summed across all origins to a destination, city j. Therefore, we are predicting the attraction of any city for the employment of residents who live in each surrounding city i -- across all cities in the region (m representing the total number of cities/subregions). Of course, these probabilities (from city i, to all other cities, j) sum to unity for all trips originating in city i, and being attracted to all other cities in the region, j. Then, the proportion living in city I is multiplied by those who will likely travel to city j (far away). The residential workers end up in city j, and we aggregate the trips for all destinations across j. The result is an estimated distribution of employment at each place of work. This model is no project trend, in the sense that it utilizes the existing transit network, assuming no major transportation improvements. This is exactly what a "trend projection" would show if there were no significant improvements of the existing transportation infrastructure, or changes in transportation mode choice.

B-2-3. No Project Employment Forecast

EMPLOYMENT

Recent Trends

1. Recent data from EDD shows that job growth of SCAG region has been slow down since 2000.

- Between 2000 to the first half of 2003, the 0.2% annual job growth rate is very low, compared to 2% during 1993-2000 period. In addition, SCAG Region has lost 40,000 jobs since 2001.
- SCAG Trend Projection was completed in 2002. Recent job slowdown was not included.
- The difference is significant: 2003 employment estimated by Trend Projection is about 6% (432,000) higher than actual data.
- Unemployment rate jumped to 6.1% in 2003 from 4.9% in 2000.

Recent Trends of Total Employment (x 1,000)

	2000	2001	2002	2003	2000-2003
EDD Data*	**7,482**	**7,560**	**7,536**	**7,520**	**38**
Trend Proj.	7,482	7,639	7,795	7,952	469
Diff (Trend Proj. - EDD)		78	259	432	
% Diff		1%	3%	6%	

* Include self employment

2010

- Time-series regression analysis with 1993-2003 employment data.
- Unemployment rate assumption: 6.1%
- 2010 employment estimate: 8.78 million
- 269,000 lower than Trend Projection, 135,000 lower than Local Input
- 2010 county distribution: Local Input

2030

- Trend Projection has considered the impact of aging baby boomer on future job growth. It is reasonable to keep the growth pattern of Trend Projection between 2010-2030.
- 2030 employment estimate: 10.17 million, which is 267,000 lower than Trend Projection, and 117,000 lower than Local Input
- 2030 county distribution: Local Input.

B-3. Small Area No Project Forecast

The small area no project socioeconomic projection refers to the trend projection of population, household, and employment at the SCAG's Transportation Analysis Zone (TAZ) and the US Census Tract (CT) levels from 2000 to 2030 in five year increments. It is built upon the small area trend projection and local input projection.

B-3-1. Small Area Trend Projection

The small area trend projection is done in a two-step process. The first step is the projection of 2030 small area households, population, and employment. The second step is the projection of 2005 through 2025 small area households, population, and employment in five-year increment.

Current land use, city general plans, and regional policies are not included in the small area trend projection because it is a pure technical "trend" projection.

1. Projection of 2030 Small Area Households, Population, and Employment

Households

The first step is to allocate 2030 single households (SDOs). This is done by comparing the CT-TAZs 1990 to 2000 growth in SDOs with their cities' growth in SDOs for the same period. SCAG applies that same relationship to the cities' 2000 to 2030 growth to infer each CT-TAZ's share of that growth. This 2030 CT-TAZ projection is than averaged with SCAG's 2001RTP projection for the same CT-TAZ to get a final projection. These projections are adjusted to make sure they are consistent with the city's forecast.

The next step is to project 2030 total households by first estimating each CT-TAZ's percentage of single households. This is done by using the base year (2000) CT-TAZ's single percentage compared to the city's. This relationship is then applied to the city's 2030 single percentage to get the CT-TAZ's 2030 percentage.

Once the CT-TAZ's total 2030 single households and single percentage have been projected, SCAG calculates the total household projection by dividing the single projection by the single percentage.

SCAG assumes that the proportion of total households that are mobile homes or "other" (boats, RV's, etc.) is the same in 2030 as in the base year. Therefore, the projections of mobile homes and "other" households is determined by applying these base year rates to the 2030 total households.

Multiple household projections are the calculated by subtracting the previously forecasted single households, mobile homes, and others from the projected total, i.e., the remainder.

Population

The 2030 residential population projections are based on growth forecasting CT-TAZ household size. This forecasted household size is than applied to the 2030 household projection to get residential population. SCAG calculates the 2030 household size by applying the base year ratio of CT-TAZ to city household size to the city's 2030 household size.

Group quarter populations (GQP).
SCAG makes the following assumptions about group quartered population projections: no changes in military bases (closings or new construction),
no new prisons, jails, or mental hospitals will be built, and, no new major universities or colleges (except Calif. State U., Channel Islands).

The 2030 group quartered population is calculated by applying the CT-TAZ'S base year share of the city's GQP to the city's 2030 projection.

Total population is the sum of residential population and GQP.

Employment

SCAG projects employment somewhat similar to the way it projects households. First, service employment is projected. SCAG uses a mix of the base year and the 2001-RTP's 2025 CT-TAZ's share of the city's service employment. This share is applied to the city's 2030 projection of service jobs. Next, the percent of service employment to total employment is forecasted. It is done using the same method as was done for percentage of single households. Given these two projections, total employment can be calculated by dividing the service employment by the percent of service employment. Once total employment has been projected, SCAG uses the base year proportions of the other nine sectorial employment categories to get a draft 2030 set of projections by sector type. These than are adjusted to be consistent with the ten sector employment projections at the city level.

2. Projection of 2005 through 2025 Small Area Households, Population, and Employment in Five-Year Increment

Projections for each of the household, population, and employment variables was done for each five year increment from 2000 through 2025. The same method was used for all variables. This method is a form of interpolation referred to by SCAG staff as the "shares" method.

The shares procedure uses, for each of the interim five year periods, the city's proportional "consumption" of its 2000 to 2030 growth as the basis for interpolating each CT-TAZ's values. It is assumed that all small areas will add (or, in some cases, lose), from their 2000 to 2030 growth, each five years at the same proportional rate as their respective cities. For example, if a city reaches twenty percent of its 2000 to 2030 growth by 2010, all of its CT-TAZs will also reach the same percentage of their 2000 to 2030 growth by 2010. This method is applied to each variable.

B-3-2. Small Area Local Input Projection

After it had been completed, the small area trend projection was sent to all local jurisdictions for their extensive review. SCAG has received valuable inputs from virtually all local jurisdictions. However, the level of comments or inputs on the small area projection varies substantially by jurisdictions. As a result, different approaches have used to develop the small area local input projection.

For local jurisdictions that have provided complete small area inputs consistent with their jurisdictional level inputs, the small area inputs from local jurisdictions form the local input projection for these jurisdictions.

If there are inconsistencies between small area and jurisdictional level inputs, the small area local inputs are normalized to the jurisdictional level inputs. The revised small area inputs then become the final local input projection for these jurisdictions.

For those jurisdictions that only provided jurisdictional inputs, the small area trend projections is normalized to the jurisdictional level inputs to form the small area local input projection.

For the remaining few jurisdictions that have not provided any local inputs, the small area trend projection becomes their small area local input projection.

Because it is from or agreed by local jurisdictions, the small area local input projection can be reasonably assumed to have reflected the current land use and existing city general plans.

B-3-3. Small Area No Project Forecast

The small area No Project Projection is based on (1) the small area distribution from small area Local Input Projection and (2) the city level Trend Projection (The whole unincorporated area in a county is treated as it were a city). The small area is defined as the SCAG TAZ and city combinations for Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties. For Imperial County, the small area is the Imperial County Transportation Analysis Zones (TAZs). The small area distribution includes (1) the small area to city ratios for total population, household, and employment variables and (2) the small area level secondary variable to primary variable ratios. Total population, household, and employment are the three primary variables while the rest variables such as resident population, occupied single dwelling units, and service sector employment are considered as secondary variables.

For Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties, the small area No Project Projection was developed through the following two major steps:

Step 1. Calculate the three primary variables by normalizing the small area level total population, household, and employment of the small area Local Input Projection to the city level total population, household, and employment of the Trend Projection. The method used is the delta normalization method which preserves the total population, household, and employment trends in the small area Input Projection.

Step 2. Calculate all secondary variables by applying the small area level secondary variable to primary variable ratios to the normalized small area level total population, household, and employment.

For Imperial County, the small area No Project Projection was developed through the following four major steps:

Step 1. Calculate the three primary variables by normalizing the partial census tract level total population, household, and employment of the small area Local Input Projection to the city level total population, household, and employment of the Trend Projection. Again, the method used is the delta normalization method which preserves the total population, household, and employment trends in the small area Input Projection.

Step 2. Calculate all secondary variables by applying the partial census tract level secondary variable to primary variable ratios to the normalized partial census tract level total population, household, and employment.

Step 3. Convert all the primary and secondary variables from the partial census tracts to the Imperial County TAZs.

Step 4. Adjust the employment by sector to reflect the unique peak season employment situation in the Imperial County: significantly higher employment in the agriculture sector, slightly lower employment in the service sector, and slightly higher employment in the remaining sectors.

C. Local Review Process

As part of the RTP update process, SCAG is required to update socioeconomic forecasts based on the latest information available. These forecasts provide critical input to the development of the 2004 RTP. Review by local jurisdictions is essential to ensure the credibility of the analysis.

The local review process for the development of the 2004 RTP socioeconomic forecast took place from middle of September through early December 2002. Data reviewed by the local jurisdictions include primary variables such as population, households, and employment.

SCAG sent a local review package to each jurisdiction in middle of September, 2002. The package contented forecast methodologies, data table and disk, maps by census tract, and a local review form requiring to be signed by each city-planing department.

In assisting local jurisdictions to understand growth forecast and provide local input, SCAG staff has worked with staffs from subregions and local jurisdictions to hold joint workshops. Total of ten local review workshops were held in October, 2002 at different places in SCAG region. They were held at the City of Azusa, the City of Carson, the City of El Centro, the City of Moorpark, the City of Riverside, the City of Santa Clarita, the Coachella Valley Association of Government Office, the Orange County Transportation Authority Office, the San Bernardino Association of Governments Office and the SCAG office. The methodology and the development of the Growth Forecast were presented and discussed at all workshops. More than two hundred people attended those workshops.

In responding to SCAG's request of local review and input, staffs from Subregions and local jurisdictions made a great effort to complete the local review process. Many local jurisdictions have reviewed the draft growth forecast data and provided the revised data with supporting documents. Overall, ninety percent of local jurisdictions have returned the local review form and provided valuable local inputs before the deadline.

The local input data set presented in the 2004 RTP appendix are those SCAG received from local jurisdictions from middle September through early December, 2002. For the ten percent of cities that did not provide any local inputs, the original trend projection data were used in the local input data set.

D. Plan Forecast Methodology

D-1. Regional Plan Forecast

Destination 2030 proposes the use of a Regional Plan Forecast. This is a policy choice based on transportation/ land use strategies that maximize the existing transportation system infrastructure through the use of the best performing elements of several technical trend projections and two Compass growth visioning scenarios promoting infill and outfill development in the region. The resulting policy scenario is then a hybrid between several extremely different blueprints for guiding development, and includes an economic development component (privately-funded projects) as well as the best performing elements of each trend projection.

1. Planning for Integrated Land Use and Transportation (PILUT)

The 2004 RTP Plan Forecast is a product of extensive evaluation based on the Planning for Integrated Land Use and Transportation (PILUT) process. PILUT evaluation process links future land use scenarios with transportation strategies that promote transit oriented development, job housing balance and centers based development. It is guided by the Compass Growth Visioning effort, which SCAG introduced as an interactive public outreach tool initiative. Compass allows participates in public workshops to distribute homes and jobs across the region, decide where transit lines should go, what new roads are needed, and what places should be preserved as parks or open space. This feedback is then used to frame and inform SCAG's long range growth planning.

Initially, five RTP growth alternatives including three variations of balancing trends with local input and two PILUT scenarios were developed for evaluation purposes. Each of these RTP growth alternatives assumed a different approach in aligning regional and local land use strategies. For example, a compact/infill regional growth pattern is featured in PILUT scenario 1, while a dispersed, urban edge growth pattern is featured in PILUT scenario 2.

As a result of evaluating these five initial growth alternatives, the hybrid growth alternative or Preferred Plan (Plan Forecast) is proposed to include the decentralized aviation strategy, and privately-funded projects, and the selected land use strategies including the jobs-housing strategy, transit oriented development, and centers growth strategy. The hybrid growth alternative (Plan Forecast) is found to be the best performing growth alternative based on performance indicator evaluation criteria.

In contrast to the Preferred Plan alternative (Plan Forecast), the 2004 RTP No Project forecast is a no project projection envisioning only short-term improvements to the transportation system. It is derived from sound technical analysis of historical trends and defined by an extensive local input and review process. The No Project Forecast of population, household and employment are considered to represent an unconstrained future growth scenario, introducing no new regional policy. Only those programmed transportation projects that have federal environmental clearance by 2002 are assumed. This fulfills the RTP No Project and CEQA No Project requirements. The following table compares the Plan Forecast with the No Project Forecast in terms of the projections for population, households and employment.

Table XX. 2004 RTP Final Population, Household, and Employment Growth in 2030: No Project and Plan Forecast (In Thousands)									
	No Project Forecast			Plan Forecast			Difference (Plan minus No Project)		
	Population	Households	Employment	Population	Households	Employment	Population	Households	Employment
Imperial	270	84	110	270	84	111	0	0	1
Los Angeles	12,227	4,079	5,549	12,222	4,120	5,661	-5	41	112
Orange	3,553	1,098	1,922	3,553	1,098	1,922	0	0	0
Riverside	3,143	1,048	1,053	3,143	1.128	1,189	0	80	136
San Bernardino	2,713	842	1,071	2,713	898	1,179	0	56	108
Ventura	984	325	454	990	332	465	5	7	12
SCAG Region	22,891	7,476	10,158	22,891	7,660	10,527	0	184	369
Source: No Project forecast - incorporating local input and review from 90% of cities and subregions.									
Plan forecast - growth additions among counties based on privately-funded projects.									

The Plan Forecast provides for no further population increase. But it does call for extensive economic development and reinvestment in the region's infrastructure and goods movement transportation system. The added job growth and household growth resulting from implementation of the new privately-funded projects based economic development strategy are the distinguishing differences between the Regional No Project and the Plan Forecast.

2. Scenario Planning

The process employed in the creation of the PILUT alternatives and the Draft Growth Vision is called scenario planning. Scenario planning is widely used in business and military settings. Given the complexity of the issues we face in today's environment, the number of variables that have to be considered, and the planning horizon time frame, it is apparent that getting the right prediction really isn't possible or even necessary. What is needed is a way to put forth possible future scenarios.

Scenarios are in essence stories about what might be. They are not forecasts and they are not predictions. They are possible futures based on what already exists, on trends that are evident, and on the values and preferences of our region. Fundamental to scenario planning is an understanding of driving forces that are beyond our control. The national economy and the physical landscape are both good examples of these forces. Within the construct of the scenario we then identify and test forces such as transportation and land use for which we do have some control. The essential requirement of any scenario is that it be plausible, within the realm of what exists and what is now known. Multiple scenarios are built as a way to compare outcomes and learn about the forces that are shaping the future. If a particular outcome is preferred, it can be selected as a plan.

Each of the scenarios represents a different snapshot of the future with its own attendant consequences. The scenarios will allow us to compare how different growth patterns are likely to shape or affect the future. Ultimately, a scenario can serve as a vision of the future, or elements of multiple scenarios can be combined to create a regional vision.

In addition to selecting a vision, scenarios can be especially helpful in selecting the right strategies. For example, if a key investment performs well in multiple scenarios, it is said to be

robust. If an investment odes well in only one scenario, it is **fragile.** Clearly, where possible, strategies that are robust are more likely to succeed in an uncertain future.

3. Scenario Building Process

- **General Guidelines**

The process followed by FCA is different from alternatives analysis based on policy assumptions. It is based not on a set of general assumptions applied across the board, but rather on a series of fine-scaled decisions applied on a site-by-site basis. Often in traditional planning, alternative scenarios are created to explore an assumption, such as a certain percentage increase in development within districts such as downtown or transit areas. The error in this logic is twofold.

First, the future will not unfold by responding to just one trend. Many forces are active at all times. The market very well may respond to one of these assumptions. However, simultaneously, the market will also be acting differently on other areas. Transit areas, for example, may be likely to see increased investment along with investment in downtowns, rather than one succeeding while the other fails. It would be unwise to consider just one assumption without taking the others into account.

Second, these types of assumptions ignore the existing conditions. In doing so they may create an end state that may or may not be plausible. A plausible end state is fundamental to scenario design. The FCA method of creating scenarios is based on first creating a virtual 'today'. This is represented in GIS by creating dozens of map layers that describe the conditions that currently exist. Armed with a true understanding of today, FCA then builds the scenarios by creating virtual 'futures'. In following this method the scenarios are built upon a wealth of data. This data is a combination of both the conditions today, as well as a detailed assessment of the types of development that may occur in the future.

- **Fixed Assumptions –Control Totals**

Both PILUT 1 and 2 scenarios have their basis within a series of control totals received from SCAG. The Hybrid is based on the control totals found in SCAG's 'No Project' alternative, with balance at the city level made to within 10% of the growth identified through local input. In defining the scenarios, SCAG provided a mix of housing and jobs for each of the six counties and two subareas within the region. This allocation was broken down to include population, households, and three categories for employment.

- **Changing landscapes within fixed control totals**

Within the control totals, FCA built the foundation of the scenario development process – 'building types'. Based on real world examples found within the Southland, a set of virtual building types was established. From the mix of uses and jobs and housing types to building height and parking requirements, these building types represent a wealth of data, applied at the smallest level of geography available.

Groupings of building types are combined to define 'development types'. A set of 15 development types was created using samples of existing developed land in the region. These are based on places experienced by residents and workers alike; they carry with them all of the details of life necessary to understand the virtual place they represent.

At there most basic level development types represent households and employees for a given amount of land. In addition to this simple representation of density, information can be associated with these development types indicating many factors, such as the amount of impervious surface, percentage of rental units, single-family and multi-family mix, infrastructure costs and other derived assumptions. Scenarios are populated using development types, allowing the direct comparisons between them via evaluation criteria such as land consumption, comparative infrastructure costs and housing and job profiles.

The development types are combined with what is known about the landscape to create the virtual futures that form the test scenarios. The important facet to note at this time is that the scenarios are indeed built upon a very detailed analysis of the landscape and plausible future developments. Also keep in mind that the scenarios themselves are host to a wealth of data that can be used for further modeling, performance monitoring or ground truthing.

4. Description of the Scenarios

- **PILUT 1**

This alternative is often referred to as the ‘Infill’ scenario. It is based on an intense realization of the growth potential of the coastal plain. In this scenario the city of Los Angeles, building upon its growing multi-ethnic population, will be transformed into an international city rivaling any in the world.

Both Jobs and housing growth would be focused on existing centers and corridors throughout the Region. Los Angeles would be home to significant amounts of growth with the vast majority taking place through infill development. The intensive network of transportation corridors would be the target of much re-investment. This would create highly desirable places to live in close proximity to the jobs of the central city, and locate both jobs and households within proximity of excellent transit service.

Beyond the Coastal plain cities would experience a large amount of investment, with only small amounts of new commercial areas being created. To reduce trips and make transit more widely available, development that might currently locate along interchanges would instead be focused on the existing well-connected road network, near transit access, and existing services. This development will be mixed in nature, with close proximity to goods and services for the new households.

- **PILUT 2**

This alternative is often referred to as the ‘Fifth Ring’ scenario. It is based on a broad distribution of future growth in the region. While the basin is still popular, an increasing share of growth will locate in newer cities, with places like Palmdale and Ontario becoming regional centers with growth similar to that experienced by Orange County in the 60’s and 70’s. Because most of the development occurs at the edge of what is developed today, many currently separate towns and cities will grow together. The growth of the outer ring cities will transform the region, bringing economic growth to areas that have seen little change over the last decade. The region will become polycentric, with Palmdale, San Bernardino/Riverside, and Los Angeles operating as the three large centers from which growth extends

With the outward expansion in business growth, Los Angeles will not see the extent of growth seen in PILUT 1. Focused on the Ontario airport, San Bernardino and Riverside will merge to become one significant job destination. Palmdale will grow at a rate and density similar to Las Vegas during the last decade – minus the casinos.

There will be a significant number of new jobs coming to these emerging areas as manufacturing finds its place among the new investment in airports and the centers. Accompanying all of these jobs are thousands of new homes providing for a balanced mix of jobs and housing that will enable an efficient transportation system.

Within the centers themselves housing will play a smaller role, as commerce is king. These areas will however, be home to a significant number of homes, primarily multi-family with some small lot single-family at the edge. Redevelopment and infill will continue to play a role in the development of new housing, likely continuing at roughly the same pace as it is today.

- **Plan Forecast (Hybrid of Pilut 1 and Pilut 2)**

After the two PILUT scenarios were modeled, the Compass team met with SCAG to review the results. These two scenarios, employing land use integrated with transportation modeled significantly better than the conventionally created scenarios. Both scenarios are plausible in the long term; however, being 'bookends' neither scenario represented a 'story' about growth that could be proven to be readily feasible in the short term. Both require significant efforts. For PILUT 1 these efforts are concentrated on policy changes at the local level to focus on infill and increased transit. While PILUT 2 also required significant policy changes to achieve its compact form, it also required intensive investment in transportation facilities to spur the employment growth required in the High Desert. Based on these realizations, coupled with the successful model results, SCAG directed the team to create the Hybrid or Plan Forecast Alternative.

The hybrid (Plan Forecast) is based on a combination of what was learned from the model runs, the need to create a scenario that is realistic in both the short and long-term. Fundamental to ensuring short-term viability was the inclusion of the SCAG 2010 projections. The team recognizes that while many of the policy changes depicted by the scenarios were desirable, they may take some time to incorporate into local ordinances. By building the Hybrid on top of the 2010 base year, we build in a full six years for 'ramp up', or adoption of new policies. Further, the alternative was built recognizing the local input received by SCAG during the RTP process. While the locations of jobs and housing are significantly different than in the conventional models, the totals add up to within 10% of that requested by the member jurisdictions of SCAG. Following is qualitative description of the Hybrid, or Plan Forecast.

- **Employment growth**

Los Angeles will be both the cultural and financial center of the Western United States, with major markets in Asia and Latin America. With increased opportunities for work and significant reinvestment, the motto will surely be ‘place matters’. Taking advantage of the wealth of people and their varied backgrounds and expertise, major employers and corporate headquarters, along with start-up and creative-class businesses, will all be drawn to the city’s core.

The inland port inter-modal facility will become a regionally significant employer, cementing the area’s role nationally as both a job and distribution center. In the process, a large number of currently underutilized industrial sites in the City of Los Angeles will become available for new uses.

Beyond the coastal plain, the shape of new development will undergo change. Auto-oriented commercial uses, from stores to offices, will continue to develop to a lessening degree as the fall out of favor. Instead, existing cities will become the choice location for new jobs, combining with existing employment to strengthen the centers. These cities are locations with a well-connected street system, efficient freeway access, and many transit options.

- **Household growth**

With its increase in employment, LA and Orange counties will become significant magnets for housing growth. Rising congestion and the availability of jobs would discourage long commutes to outlying areas and services close by. With many new residents from areas with high urban densities, the new population would be more adaptive to urban living. The new availability of old industrial sites within the basin will provide a much-needed increase in land available for housing. These areas will be transformed into new neighborhoods, complete with a range of housing options and excellent accessibility to the jobs, entertainment, and cultural aspects of the basin. New housing will sprout at a rapid rate along the transportation corridors that so define the area. This resurgence will provide housing for thousands of people through infill and redevelopment.

Throughout the region existing centers will more and more become the focus of new places to live. Like the basin, but on a smaller scale, these areas will to some extent replace the demand for the subdivisions that are today ubiquitous, as people choose to live closer to work, shopping and transit.

- **Transportation infrastructure**

The vast network of corridors that help to define the basin will undergo a transformation, as these boulevards will become the focus of people’s attention. These will be places that, with their high quality transit, fueled by the massive demand from new residents, will play the dominant role in people’s daily lives. They will shine as a signature to the health and vitality of the basin. Transit will play an even greater role in serving people’s daily needs.

A combination of increased separate lane, or fixed guideway bus and rail transit, along with growth in traditional buses, will enable quick and easy travel throughout the basin. Los Angeles and Orange Counties will become part of a seamless transit network. For longer distances, high-speed trains and MAGLEV will fill a role of ever increasing importance. Center to center travel and today’s in-state flights will be served with great ease by this high-speed system.

The Ontario airport will experience a unique type of growth as it is developed to an international standard. LAX, without expanding the number of planes using this destination will shift to become more of a national and international airport, largely eliminating short distance flights, which are replaced by high-speed rail service. The connection to the world from these two airports will further cement the area's position in the global marketplace. Smaller airports around the region will absorb the demand for some of the flights from this and other nearby states, while the majority of the short-haul trips will be taking place by rail.

5. Policies

Critical in realizing the future described above is a certain set policy actions. These policies become in fact the drivers for the creation of the scenario. Think of these as the rules to which the planner must conform while creating this virtual future. Following is a list of some of the key policies inherent in the Plan Forecast.

- Transform Ontario Airport to an international standard.
- Implement a far-reaching, efficient system of high-speed trains
- Realize the full potential of the inland port
- Tailor land use policies to encourage the reuse of defunct industrial areas.
- Rezone land along corridors to realize maximum benefit of land-use and transit interaction
- Invest in exclusive lane rapid transit, and expand to new areas, such as a coastal line
- Integrate LA and Orange County transit
- Implement privately-funded projects

D-2. Small Area Plan Forecast

Small area projections refer to the growth forecasts done at the Census Tract and Transportation Analysis Zone (CT-TAZ) for the year 2030 and each five years interval from 2000. There are over 8000 CT-TAZ combinations.

In keeping with the philosophy of scenario planning, Fregonese Calthorpe Associates has performed a research project to examine several scenarios and to see what effects of various land use alternatives would be on transportation performance. While a lot of theory has been espoused, there has been little applied pragmatic work done to examine what realistic choices are available to the residents of Southern California.

Fregonese Calthorpe Associates created many growth scenarios for the Southern California region. Each represents a different snapshot of the future with its own consequences. The scenarios will allow us to compare how different growth patterns are likely to shape or affect the future. Ultimately, a scenario can serve as a vision of the future, or elements of multiple scenarios can be combined to create a regional vision.

Through the use of robust computer planning tools the scenario policies and development types were combined to create the virtual futures that form the test scenarios. These scenarios were engineered not as draft visions, but as studies that could inform the creation of the draft vision. The important facet to note at this time is that the scenarios are indeed built upon a very detailed analysis of the landscape and plausible future developments.

Based on many scenarios and analyses FCA created Hybrid (plan forecast) version. Its methodology incorporated many sources of data covering the region from a variety of sources. The primary reference layers were from SCAG(regional land use 1993), 1992 and 2001 satellite data, and 1990 and 2000 Census data. Additional data included general plans for each of the counties, environmental layers and derived layers from the digital elevation model.

These layers were combined to create a database that could be queried to provide the most accurate available land use information. The database first located 1990 population using Census block data then allocated the 2000 population form the most recent Census blocks. These data layers were used to make decisions about the most likely location of future households at a fine level of geography. Jobs were located in a similar manner using historic Transportation Analysis Zone (TAZ) data and a combination of 1993 Land Use inventory and 2001-satellite imagery.

The Hybrid alternative (Plan Forecast) is based on a combination of what was learned from the model runs, the need to create a scenario that is realistic in both the short and long terms. Fundamental to ensuring short-term viability was the inclusion of the SCAG 2010 projections. The team recognizes that while many of the policy changes depicted by the scenarios were desirable, they may take sometime to incorporate into local ordinances. By building the Hybrid on top of the 2010 base year, we build in a full six year for ‘ramp up’, or adoption of new policies. Further, the alternative was built recognition the local input received early this year during the RTP process.

After the Hybrid alternative at TAZ level was selected as our Plan Forecast the city level projections were created. There are two control totals for small area processing at this forecasting. One is city level data and other is TAZ level data. Small area data at either the tract level or a combination of CT-TAZ level must sum to the totals of both city and TAZ level. In order to have a CT-TAZ level database connected to both city level and TAZ level projections an IPF (Integrative Proposition Fitting) method was used. This was a pure mathematical approach to smooth out the database to get as close as possible to both city level and TAZ level projections.

Glossary

TOTAL POPULATION. Total population.

RESIDENT POPULATION. Population not living in group quarters.

INSTITUTIONALIZED GROUP QUARTERED POPULATION. Institutionalized group quarter population. It includes correctional instituions, nursing homes, and mental hospitals.

NONINSTITUTIONALIZED GROUP QUARTERED POPULATION. Noninstitutionalized group quarter population. It consists of students in dormitories, military personnel in barracks, and the population in homeless shelters.

TOTAL HOUSEHOLDS. Total households. Total occupied housing units.

SINGLE OCCUPIED HOUSING UNITS. Single occupied housing units with detached roofs.

MULTIPLE OCCUPIED HOUSING UNITS. Single occupied housing units with attached roofs (condominiums), duplexes, triplexes, and apartments.

MOBILE OCCUPIED HOUSING UNITS. Mobile homes or trailors.

OTHER OCCUPIED HOUSING UNITS. Houseboats, railroad cars, campers, and tents.

WORKERS. Civilian full and part-time employed It includes self-employed. Counted by place of residence.

EMPLOYMENT. Total jobs counted by place of work. Self-employment included.

AGRICULTURE: Agriculture jobs counted by place of work. Self-employment included.

MINING: Mining jobs counted by place of work Self-employment included.

CONSTRUCTION: construction jobs counted by place of work. Self-employment included.

MANUFACTURING: manufacturing jobs counted by place of work. Self-employment included.

TRANSPORTATION, COMMUNICATIONS, UTILITIES: transportation, communications, utilities jobs counted by place of work. Self-employment included.

WHOLESALE TRADE: wholesale trade jobs counted by place of work. Self-employment included.

RETAIL TRADE: retail trade jobs counted by place of work. Self-employment included.

FINANCE, INSURANCE, AND REAL ESTATE: finance, insurance, and real estate jobs counted by place of work. Self-employment included.

SERVICES: service jobs counted by place of work. Self-employment included.

GOVERNMENT: government jobs counted by place of work. Self-employment included.